Materials Engineering in Product Design & Manufacture

Materials & Methods

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How to Select Wrought Steels—M & M Manual No. 117 page **111**

Rigid Heat-Resistant Polyethylenes page 88

New Vacuum Brazed Clad Metals page 100

New Index for Materials and Processes page 82

Tear-Resistant Silicone Rubber page 106

Small Volume Production of Metal Powder Parts page 92

New Molded-In Finish for Reinforced Plastics page 104

Complete Contents page 1

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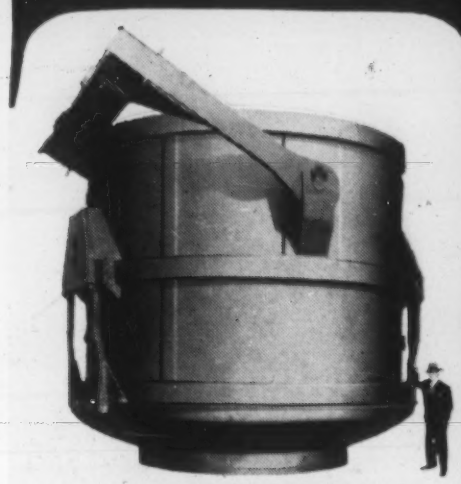

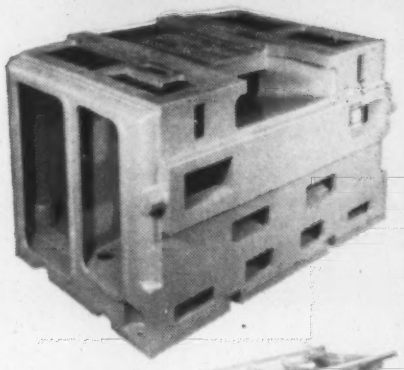

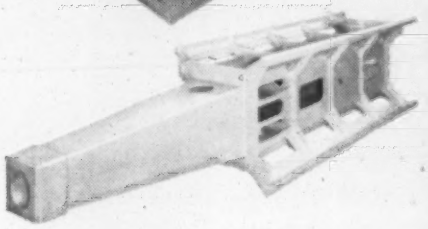

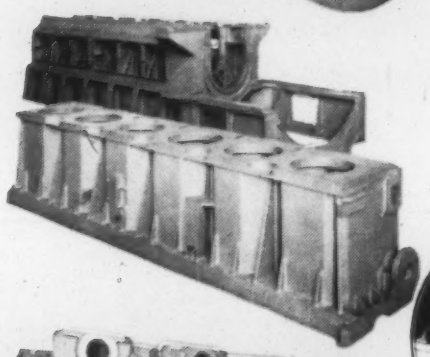

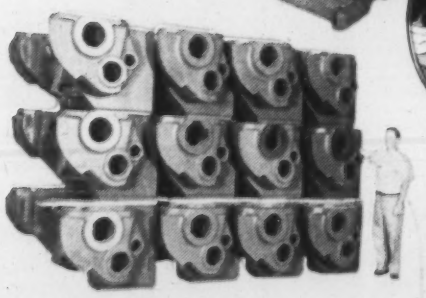

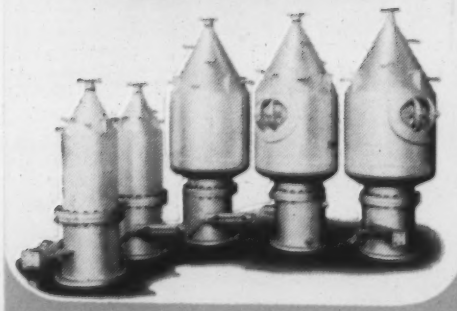

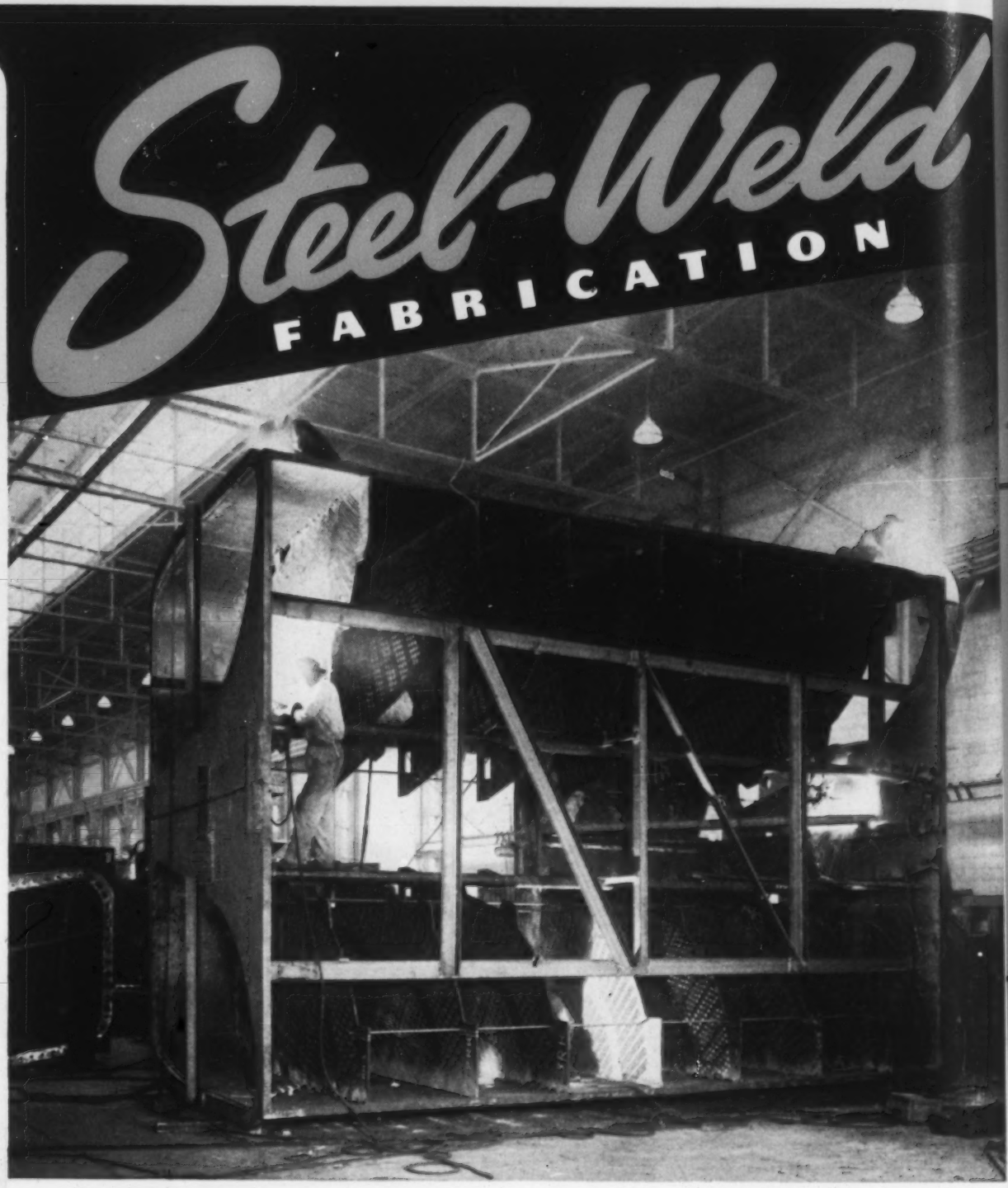

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Materials & Methods is indexed regularly in the Engineering Index and the Industrial Arts Index

FEATURE ARTICLES

New Index for Materials and Processes 82
Use this punch card system to index your technical literature for quick reference

Rigid Heat-Resistant Polyethylenes ..... *John B. Campbell* 88
New improved plastic has promising future for pipe, housewares, wire insulation

Small Volume Production of Metal Powder Parts ..... *B. I. Horton* 92
One company's experience finds it economical in spite of traditional view to the contrary

Materials for Printed Circuits ..... *T. B. Merrill, Jr.* 94
A roundup of the latest materials and techniques being used in electronics industry

Phenolic-Impregnated Paper Honeycomb ..... *James Joseph* 98
This high strength, low weight structural material finds many aircraft applications

New Clad Metals Made by Vacuum Brazing ..... *Kenneth Rose* 100
New cladding process suitable for wide range of materials combinations

New Molded-In Finish for Reinforced Plastics ..... *J. S. Bowen* 104
A low-cost laminating technique that hides cloth and mat reinforcements

Tear-Resistant Silicone Rubber ..... *George S. Irby, Jr.* 106
Teflon reinforcement increases tear strength and oil resistance

Improve Cast Aluminum Alloys by Heat Treatment ..... *B. L. Meredith* 108
How to use solution, aging, stress relief and stabilizing treatments

Materials at Work 87, 103
Bronze Propeller. Stretched Titanium. Nylon Wire Clamps

Effect of Silicon in Submerged Arc Welds ..... *W. Simon* 132
Results of recent study answer questions on brittle welds

MATERIALS & METHODS MANUAL NO. 117

How to Select Wrought Steels ..... *John W. W. Sullivan* 111

ENGINEERING FILE FACTS

Cellulose Acetate Molding Materials—Materials Data Sheet 129

DEPARTMENTS

The Materials Outlook 3
Materials Briefs 7
Men of Materials 9
Materials Engineering News 11
Reader Service 67
Manufacturers' Literature 68
One Point of View 81
New Materials, Parts, Finishes 137
Contents Noted 165
News of Engineers, Companies, Societies 196
Meetings & Expositions 208
Advertisers and Their Agencies 242
Last Word 244

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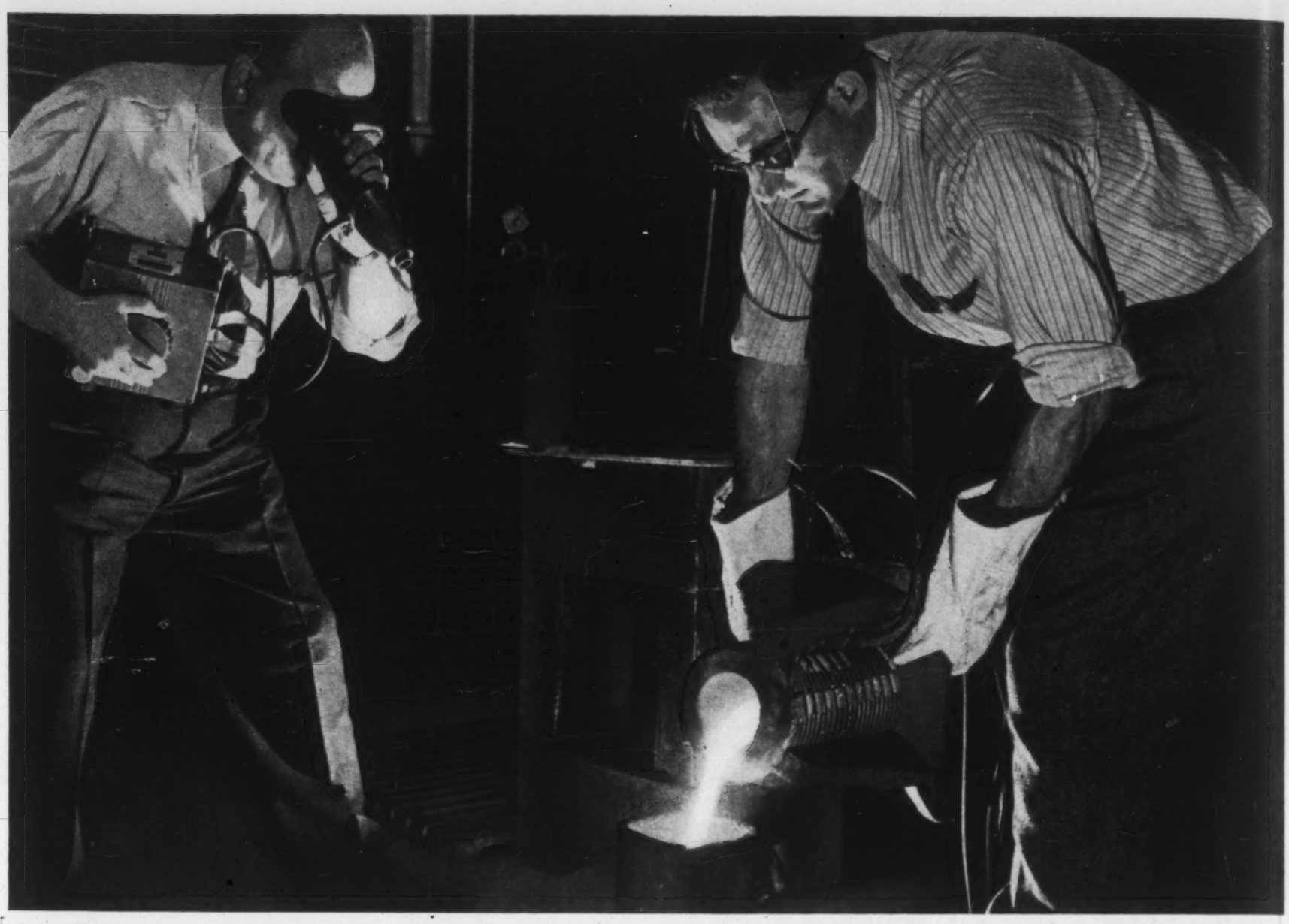

One Phase of the search for answers to high-temperature questions is the continuing development and testing of new alloys. Here Inco metallurgists pour a carefully controlled composition of metals from their laboratory radio-frequency induction furnace. The resulting alloy may help to solve some of the unanswered high-temperature problems facing engineers today.

What causes high-temperature failure?

Strange reactions can take place when metals and alloys are exposed to high heat.

Even common soot and the air itself become destructive corrosives that can disintegrate a metal and waste away its strength. The more these reactions are studied the more evident it becomes that the damage caused by high temperature corrosion is one of the most serious reasons for metal failures.

Unless a metal or alloy can resist destruction by its corrosive environment under operating conditions, it makes little difference how high or low its mechanical properties may be.

No single metal or alloy can resist all these corrosive conditions. For 20 years Inco metallurgists have been experimenting with carefully controlled compositions of metals . . . searching for the answers to the problems posed by expanding temperature frontiers. From this work have come such strong, heat-resisting alloys as Inconel® and Inconel "X"®, Incoloy® and the Nimonic® Alloys.

Yet with the gas turbine seemingly held in check by the temperature limits of metals, with the chemical and petroleum industries moving from "red-hot" to "white-hot" process temperatures, and with the development of the rocket engine and nuclear power pushing ahead, you may be asking yourself, "Have metals reached their limit of practical service at today's operating temperatures?"

Inco metallurgists think not. Who knows what future research programs may reveal?

If you have a problem involving high temperatures, the solution may already be in the files of Inco's High Temperature Engineering Service. If not, our engineers will be glad to work with you to find it. The first step is to write for a High Temperature Work Sheet, our form that helps you outline your problem for study. After that it is up to us. There is no obligation on your part.

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Materials Outlook

A FLEXIBLE INSULATING BLANKET made of alumina-silica fibers and containing no organic binder is expected to be suitable for continuous use at temperatures as high as 2000 F. These fibers have been used in bulk form for 10 years. Blankets may be useful in fire walls, back-up thermal insulation, high temperature air filters and high temperature acoustical insulation.*

NEW OR EXPANDED USES OF ALUMINUM in automobiles, according to aluminum producers, will shortly include wheels and brake drums, cylinder blocks, bumpers and grilles, trim, valve assemblies, stators and impellers, head lamp retaining rings and sockets, automatic transmission parts, and other smaller parts. . . . Another source of aluminum may open up if the embryonic plans of two major companies go through. St. Joseph Lead Co. and Pittsburgh Consolidation Coal Co. are considering an 85-million-dollar plant powered by coal that would make them the fifth primary producer of aluminum in this country.

ULTRASONIC TESTING is no longer limited to locating defects. Equipment is now available for speeding up fatigue tests; stresses as high as 60,000 psi can be applied 20,000 times a second by ultrasonic vibrations. Other equipment has been developed for nondestructive determination of elasticity and compressive strength of concrete; these properties are related to the velocity of an ultrasonic pulse through the material.

POLYESTER PAINTS are on the way. They are of special interest because of their resistance to water and chemicals and because they cure without evaporation of solvent or liberation of volatile by-products. Single coats up to 10 mils thick can be applied. One such coating developed especially for masonry-type surfaces is now on the market. Major chemical companies are working on coatings that would be suitable for plastic, metal and other surfaces.

SERVICE LIFE OF RUBBER exposed to atomic radiation can be increased "at least ten times" by addition of certain ingredients to rubber stocks before vulcanization, according to a rubber industry research executive . . . Silicone rubber that is reported to stay flexible for 150 hr or longer at 600 F is now available. Previous time limit at this temperature was less than 24 hr.

AN ADHESIVE IN FILM FORM has been developed for flat-surface bonding of metals to metals or to rigid plastics. Supported on a glass reinforcing mat, the adhesive film has up to 40 lb/in. peel strength, flows at about 200 F, and can be cured in a few minutes at 300 F under low pressures.

* (See page 214 for details)

Materials Outlook

NEW ARC RESISTANCE TESTS are being used to speed and improve the evaluation of plastics as electrical insulators. Developed by American Cyanamid, the "rotary arc" test uses a continuous arc applied to the surface of a slowly rotating disk specimen; it indicates more quickly than the standard ASTM test to what extent a material may have local areas of low arc resistance. A "rotary track" test measures the tendency of a material to track when tracking has already been started in an adjacent area.

ANTI-MICROBIAL VINYL FILM is being produced. A special surface treatment is claimed to give permanent protection against bacterial activity and mildew without impairing color, texture or hand. Expected applications: hospital sheeting shower curtains, rainwear, pillow covers and baby products.

LOWER-COST STEEL is the result of blowing with oxygen instead of air at McLouth Steel. With a charge that is 80% molten pig and 20% scrap, blowing time for a 40-ton heat is only 18 to 23 min. Savings as a result of lower investment per ton are estimated at $3 per ton. Low impurity content also makes it possible to cast high quality steel ingots directly.

PADDING MATERIAL made of nylon fibers bonded with phenolic resins is lightweight and is claimed to have high mechanical strength, to withstand dry heat or steam up to 350 F for short periods and 250 F for extended periods, and to resist cold, mould, fungus and bacterial growth. The highly resilient material is made in various densities and thicknesses, and it can be post-formed by heat and pressure.

MOLYBDENUM WIRE with better fabricating properties has been developed. Small cobalt additions make the wire more stretchable and less likely to break on grid winding machines, and apparently do not perceptibly affect electrical properties.

MESH-TYPE ABRASIVE CLOTH that does not load up in finishing is now being offered by at least two companies. The rayon mesh fabric is coated on both sides and in the pores with aluminum oxide or silicon carbide grits. It can be used for either wet or dry sanding by hand or by machine.

ADHESIVES LOADED IN SHEAR can lead to trouble if the shear strength of the adhesive has been checked only by a dynamic load test. Recent tests bear out the fact, not widely realized, that some adhesives having high dynamic shear strengths can actually support only a small fraction of the indicated loads under static conditions.

Materials BRIEFS

10 Year Hitch

Foamed neoprene mattresses have been service tested by the Navy for 10 years. Easier to clean and sterilize than cotton or other natural fiber mattresses, the mattresses are more flame resistant than foamed rubber. New York subway riders are also sitting out a test installation of neoprene foam cushions.

More Talk

A new two-inch copper tube called a circular wave guide has been developed which is capable of carrying many times the number of simultaneous telephone conversations now possible with coaxial cable. Trick is accomplished by using higher frequencies ranging from 35,000 to 75,000 megacycles.

Wheeled Research

For projects too big to be moved to a test center, Armour Research Foundation has put wheels on a complete instrumentation laboratory. If the mountain won't move to Armour, Armour will move to the mountain.

Easy on Pallbearers

Burial vaults to encase lightweight aluminum caskets are being made of reinforced plastics. Vault walls are glass fiber reinforced polyester with polystyrene linings. Top is sealed with an epoxy adhesive.

Need Molecule Men

The changeover from government to private operation of synthetic rubber plants is causing an increased demand for polymer chemists.

Rustless Heater

The first gas fired hot water heater to use an aluminum tank is now in commercial production. Aluminum pressure vessel will not rust, needs no special inside coating.

Prest-O-Lite
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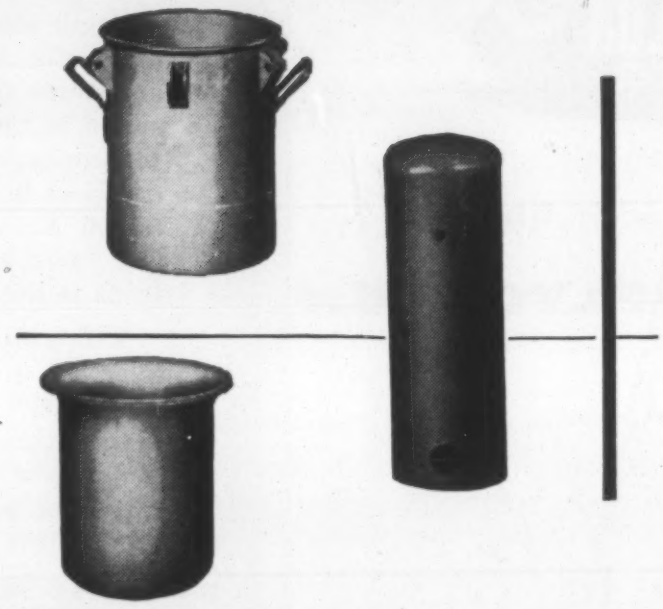
Cold-Drawn SHAPES and SHELLS

made to your specifications by Linde



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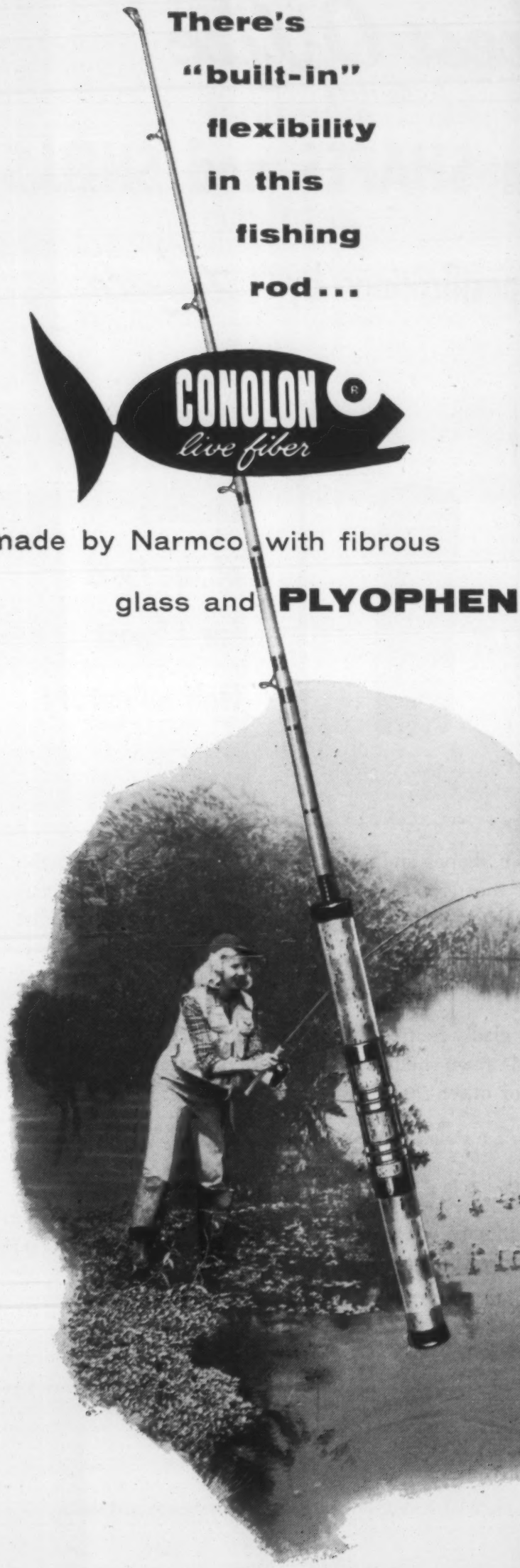
CONOLON® live fiber

made by Narmco with fibrous glass and **PLYOPHEN**



● Lively, whip-like flexibility . . . that's the vital quality of this fibrous glass fishing rod made by Narmco, originators of this type of rod. And we weren't fishing for compliments — merely facts — when we queried Narmco for their candid viewpoint on the value of our PLYOPHEN phenolic resin in the manufacture of this product.

Here's the answer . . . a direct quote from their technicians: "Regarding facts on the use of PLYOPHEN resin . . . after years of research, we have found that your PLYOPHEN resin . . . the main ingredient in our high quality fishing rod, best meets the rigid specifications that have been established in the field. We have discovered in our manufacture of these high strength tubular products that your PLYOPHEN exhibits the desirable low pressure laminating characteristics that make this material especially well suited to our patented manufacturing process . . . that the superior wettability of PLYOPHEN resins gives excellent flex properties at from 70° F. below zero to 200° F. . . . and that the high degree of color control exercised by Reichhold in this phenolic resin lends to the uniformity of color of our product."

We've little to add, except the thought that these same PLYOPHEN "plus qualities" may be just what you've been angling for in connection with your *own* fibrous glass product plans. Could be we can help you with a working sample and technical information. Just write directly to RCI.

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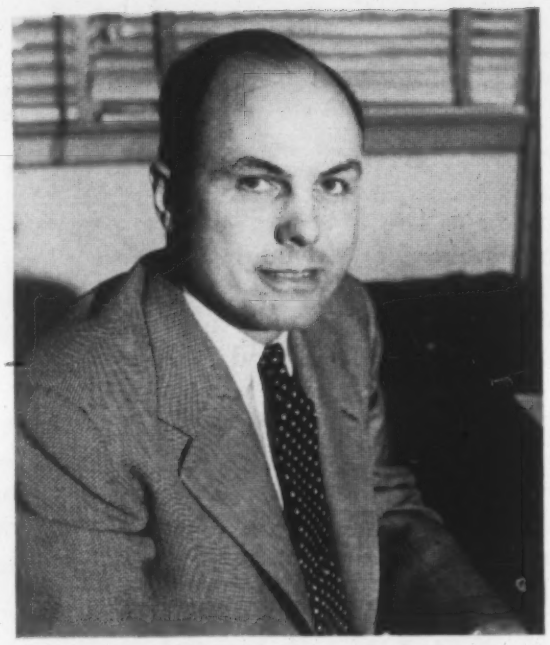
Men of Materials...



Albert M. Talbot, Technical Director of Microcast Div., Austenal Laboratories, has concentrated his efforts on the development and improvement of high temperature alloys since 1935, when he took his B.S. and M.S. degrees in metallurgy from M.I.T. At the International Nickel Co., Inc. he was part of the research team that made feasible the wide use of precipitation hardened nickel alloys. At Austenal Laboratories Mr. Talbot has spearheaded the drive to increase the versatility of the investment casting process.

Talbot predicts....

"More Investment Castings in Wider Variety of Alloys"

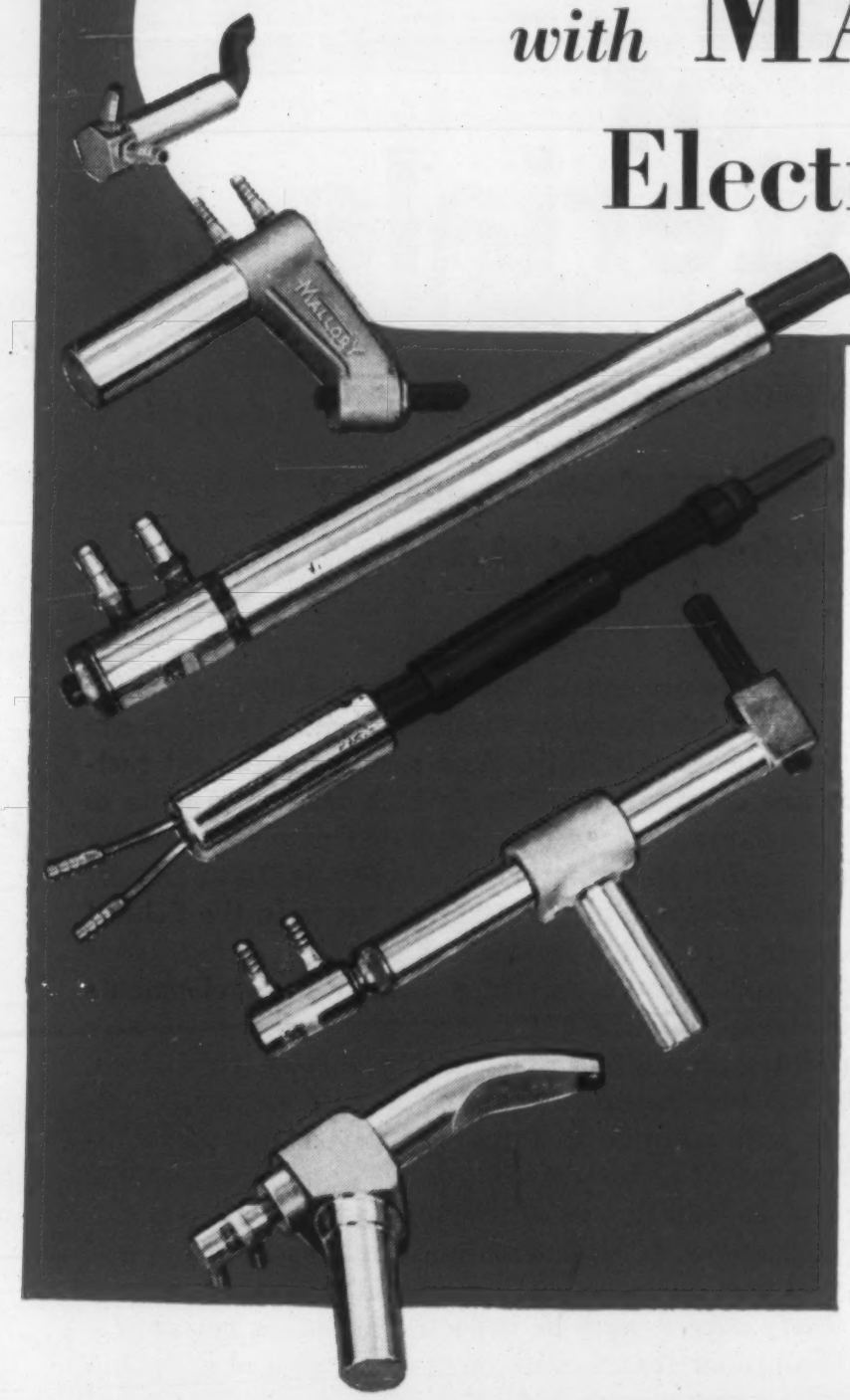
"Investment casters are constantly being called upon to handle alloys that cannot be fabricated in wrought form, and which are notorious for their poor castability. As a result, investment casting techniques are constantly evolving which make available to the designer a much greater variety of castable metals and alloys.

"It is of considerable interest to forecast some of the developments which we expect in the next few years in the field of investment casting. Actually, investment casting is only about fifteen years old, and owes its existence directly to developments in gas turbines, which require intricate parts and shapes capable of meeting high-temperature, high-strength service conditions. The demand of gas turbine manufacturers for ever better investment cast parts will continue to force new developments. However, other branches of industry will receive the direct benefits of this progress. In addition to techniques permitting a wider variety of casting alloys, in time such materials as titanium and zirconium may be cast to usable shapes. Vacuum casting, now in its formative early stages, may be expected to play a major role in improving the properties of investment castings and widening the list of materials that can be cast.

"There is continuous—almost day to day—progress toward more homogeneous, sound investment castings as a result of more thorough testing techniques. While dimensional accuracy of castings will improve in certain categories, there are inherent limitations on the degree of precision possible. A better understanding of the term 'precision castings' is evident in industry. This understanding can only result in more intelligent, proper use of investment cast parts that will ultimately benefit both investment casters and their customers."

Special Set-Ups Made Easy...

with MALLORY Electrode Holders



BEFORE you go to the time and expense of getting a custom-made holder for a welding job, take a look at the variety of standard Mallory Electrode Holders. You can probably pick out the design your application requires . . . at substantial savings in cost and delivery.

The most complete line in the industry, Mallory Electrode Holders offer many varied designs . . . straight, offset, paddle type, swivel head, low inertia, universal and close-coupled. Light, standard and heavy-duty models are available for pressure ranges from under 100 lbs. to more than 6000 lbs.

By using these versatile holders in combination with the hundreds of different types of Mallory welding electrodes, you can assemble an almost unlimited variety of welding set-ups. Most welds in channels, or other hard-to-reach locations can be made with standard Mallory welding parts. And when your application poses problems outside of the range of standard models, Mallory engineers are well qualified to design special holders and electrodes for your individual needs.

Look through the Mallory Resistance Welding Catalog and pick out a series of holders that will equip your shop for the range of work you are doing. Your nearby Mallory distributor will be glad to give you a copy of this useful catalog and to help in your selection . . . or you can get one by writing direct to Mallory.

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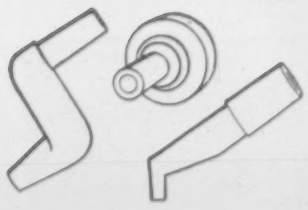

STOCK ELECTRODES

Hundreds of shapes and sizes are available in stock . . . with round water holes or the exclusive Mallory fluted cooling hole for longer life between dressings. Save you both in cost and delivery time.

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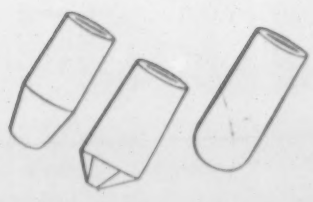
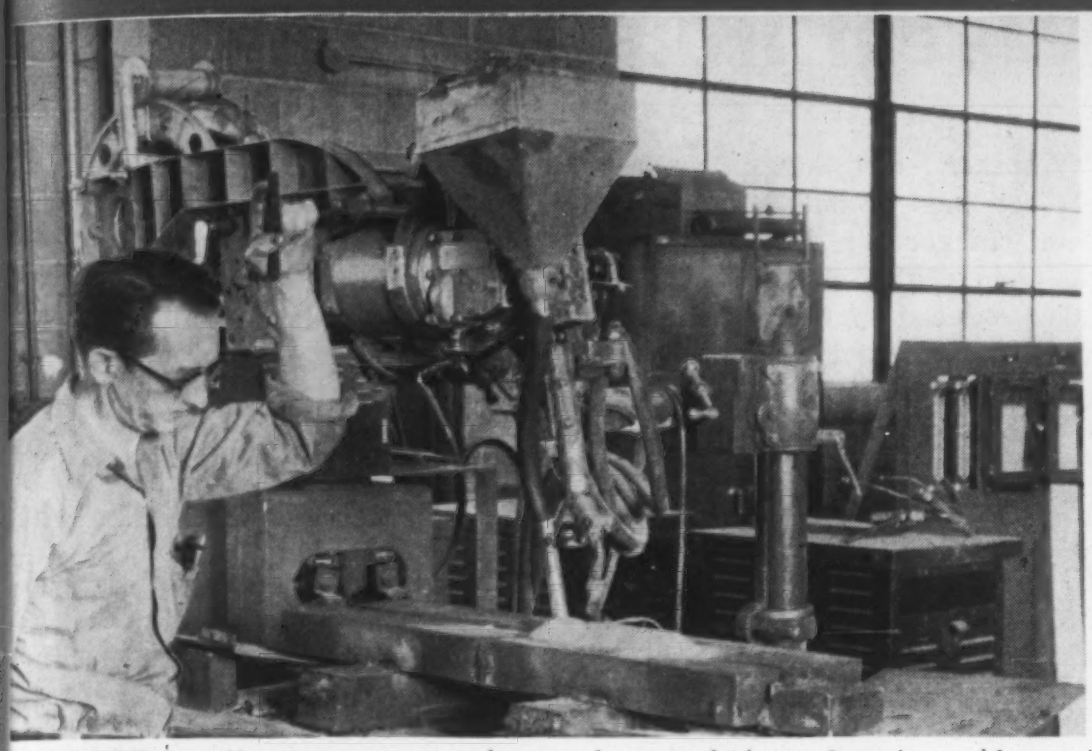
Odd-shaped electrodes you consider "specials" may well be standard items for Mallory . . . can be made quickly with existing tools, in a wide range of single-bend, double-bend and irregular shapes.

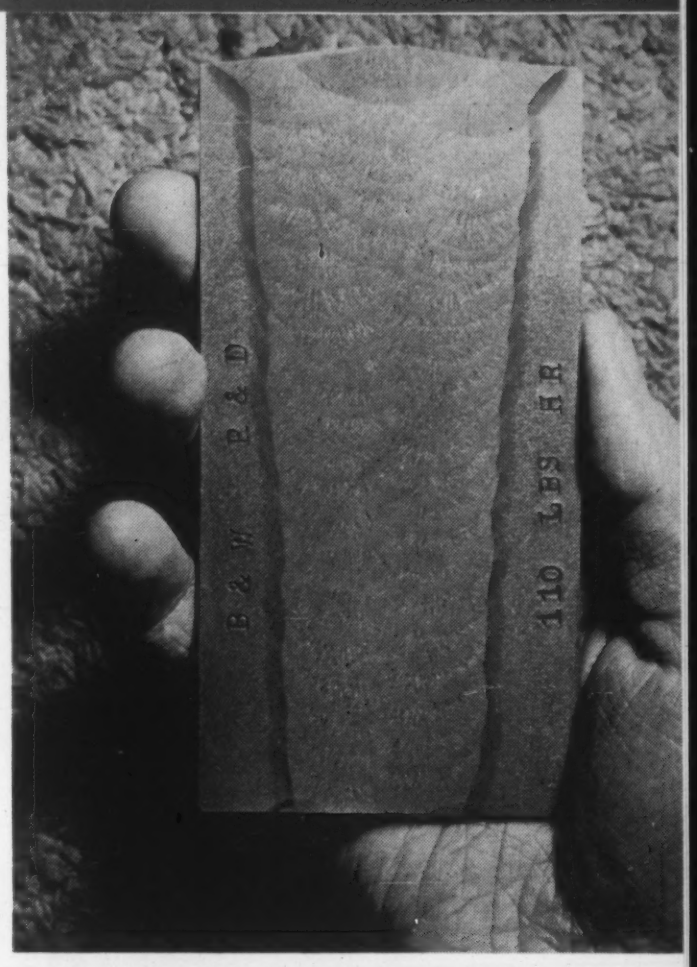


For information on titanium developments, contact Mallory-Sharan Titanium Corp., Niles, Ohio

For more information, turn to Reader Service Card, Circle No. 330



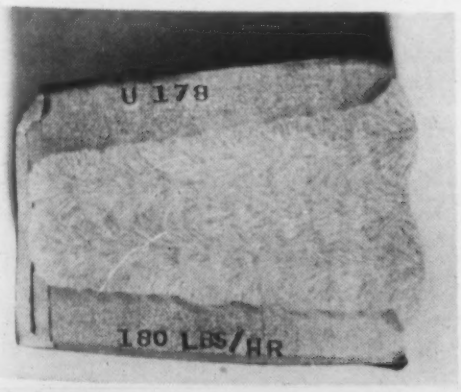
Pilot I²RT *welding set-up uses submerged arc technique, deposits weld metal at rates up to 250 lb per hr.*



Etched section *of weldment which required 50 passes. Deposit rate was 110 lb per hr.*

Boost Welding Speeds Up to Five Times

Trapped between maximum limitations on current density and maximum electrode diameter, weld-metal deposition rates have lagged behind other welding developments. A new technique has boosted deposition rates three times at standard current densities and up to five times at higher current densities. The new process, which Babcock and Wilcox developed, is applicable to both inert gas shielded welding and to submerged arc welding (in which bare electrode is fed through a layer of granular flux). Deposition rate and welding speed are so fast that manual operators can't handle the new technique —it must be automatically controlled.



Butt joint, *3 in. thick, on SA-212 steel plate deposited at 180 lb/hr.*

The secret of the process is preheating the welding electrode so that it is close to melting temperature before it gets to the arc. This is accomplished by feeding greater current through the electrode so that it heats up due to its own electrical resistance. The result is that at the gap, a maximum of the arc energy goes directly to heat of fusion to melt the electrode, since it is already hot, and less energy gets to the base metal to cause excess melting, which would occur at the high currents used were the electrode not pre-heated. The principle of the technique was discovered when it was found that within obvious limits more metal could be laid down the smaller the diameter of the electrode, which is just the opposite of flux-coated electrode theory and practice. Analysis of the apparent paradox led to the discovery that the smaller diameter electrode with its higher resistivity heated up before it got to the weld, thus allowing faster melting.

Called I²RT

The technique and theory behind the new welding process is called I²RT, after the formula for the energy required to heat the electrode to its melting temperature. Heat builds up as a function of the square of the current (I^2), the resistance (R) of the wire from contact shoe to arc, and the time (T) that the current flows through any given cross section of the wire. Thus the wire is progressively heated as it is fed through the contact nozzle until it reaches the arc.

Higher current densities are required for I²RT welding than for standard techniques. For example, current densities in electrodes vary from 70,000 to 270,000 amp

per sq in., compared to 10,000 to 20,000 amp per sq in. for standard methods. Such high densities are only possible in submerged arc and inert gas welding, since flux coated electrodes would deteriorate.

Babcock and Wilcox is currently using carbon steel electrodes with tensile strengths of 70,000 psi for production work. Experimental use of alloy electrodes indicates that they will work as well as the standard steel electrodes.

Advantages

The basic benefits derived from the new welding technique are an increase in speed and a decrease in power cost. Using a current of 1000 amp I^2RT welding deposits up to 100 lb of metal per hour. Comparable commercial techniques deposit about 30 lb per hour at the same current. Recent B&W improvements in speeding the process has led to deposit rates five times as great as any other method in use. Researchers are reportedly developing a method to deposit metal at a rate of 250 lb per hr using a current of 2000 amp.

The method is more efficient. Only 20% of the heat in standard welding techniques is used to melt the electrode. I^2RT techniques approximately double this welding efficiency, and will deposit metal at half the standard power cost.

While standard welding techniques melt base metal and filler metal in a ratio of about seven to three—seven parts of base metal to three of electrode, I^2RT welding melts about twice as much filler as base metal.

The I^2RT method can be adapted to old equipment by installing special B&W feed heads, providing suitable transformer capacity and increasing wire feed rate. Travel speed is increased, and in some cases larger or additional transformers to carry the double load voltage are required. New equipment is expected to cost no more than present automatic welding systems. The system is not adaptable to hand work.

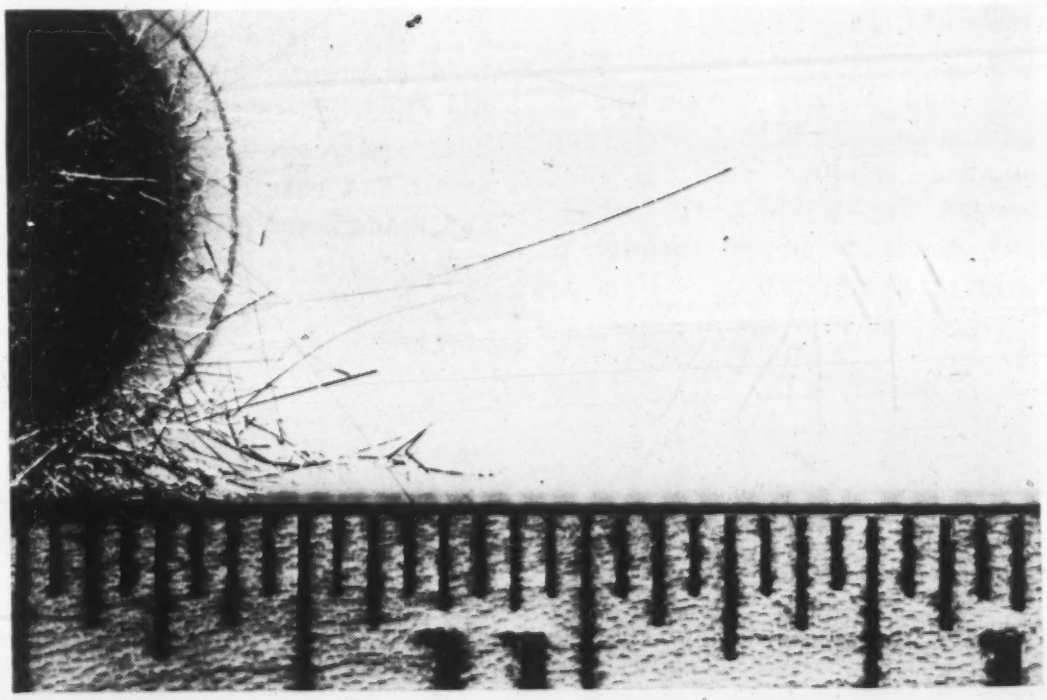
Larger Iron Whiskers Reveal Iron Properties

Another metallurgy research project has produced million-psi iron whisker crystals. Similar to the remarkable defect-free crystals produced by General Electric metallurgists last year, the new crystals from Westinghouse have greater strength than any known metal. Westinghouse metallurgists have succeeded in producing fairly large quantities of the whiskers, which are a maximum of 2 in. long and a thousandth of an inch in diameter.

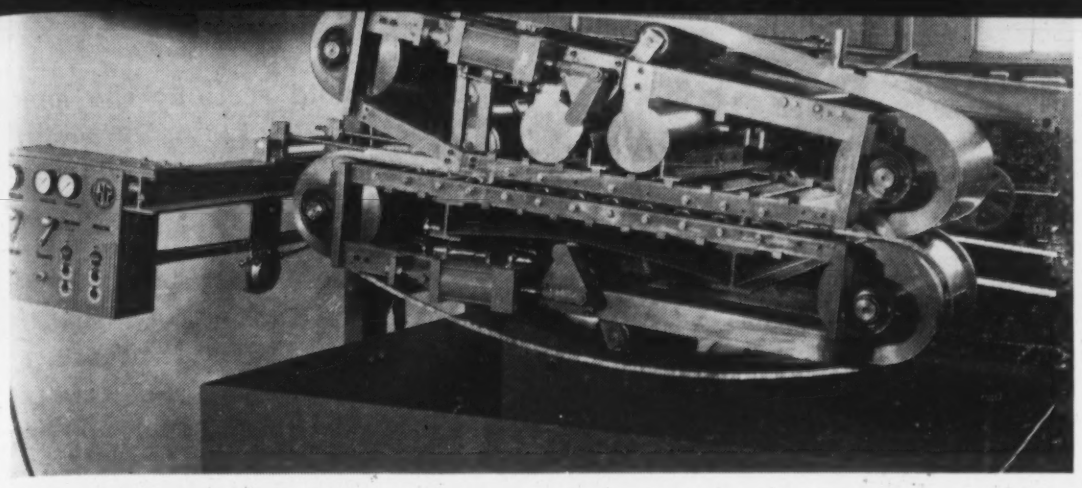
Dr. J. A. Hutcheson, director of Westinghouse research, said "Perfect iron is another forward step in our attempt to gain a broader understanding of the fundamental properties of metals. It is interesting to note that all desirable properties of metals as we know and use them today, are actually determined not by the metal itself but by the impurities and imperfections it may contain."

Very little is actually known about defect- and impurity-free metals, simply because they are not found in nature and, until recently, could not be prepared by laboratory techniques. Theory indicates, however, that many metals should exhibit properties that seem fantastic in the light of present day metals and alloys. Pure iron, for example, has an ultimate tensile strength of more than a million psi—ten times the strength of hard drawn iron wire and three times as strong as alloy steel piano wire.

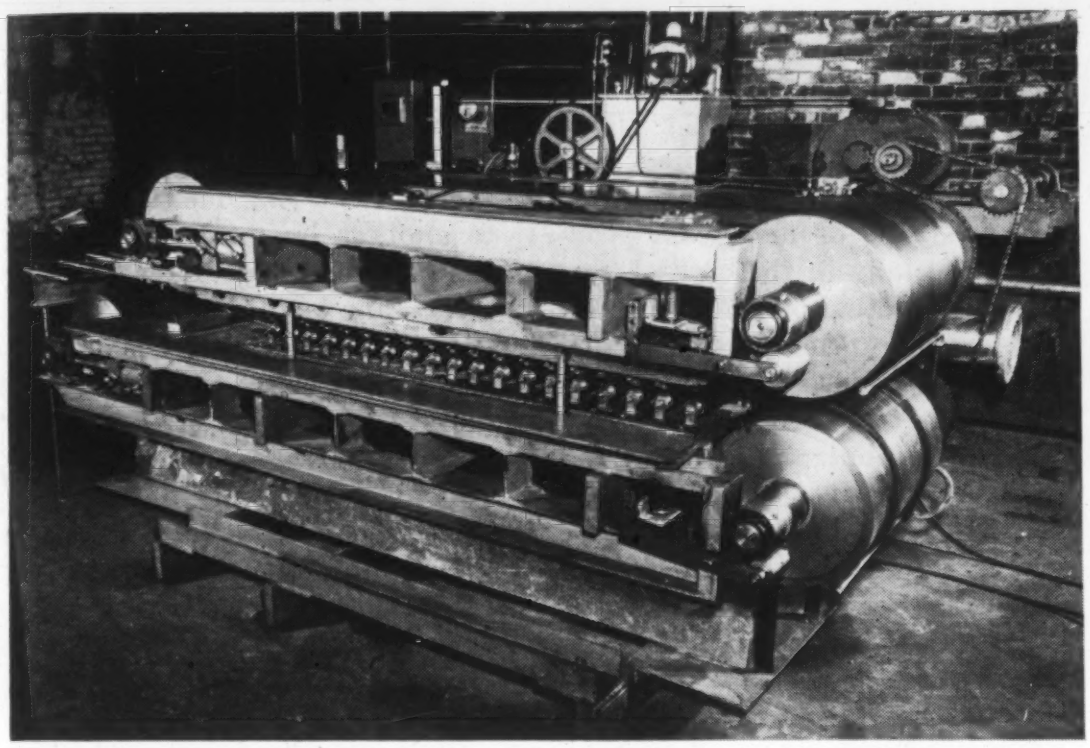
The Westinghouse perfect iron crystals resulted from the perfection of a new whisker growing technique by Dr. John C. Kelly, of the magnetics and solid state physics department. The single crystal iron is made by heating highly purified iron chloride in a hydrogen atmosphere, at a temperature of about 1100 F. By controlling the temperature and flow of hydrogen a controlled reduction of the iron chloride occurs, leaving free iron atoms which migrate toward each other and unite in perfect single crystal order. The crystal whisker which results is square in cross section and sometimes attains the length of two inches.



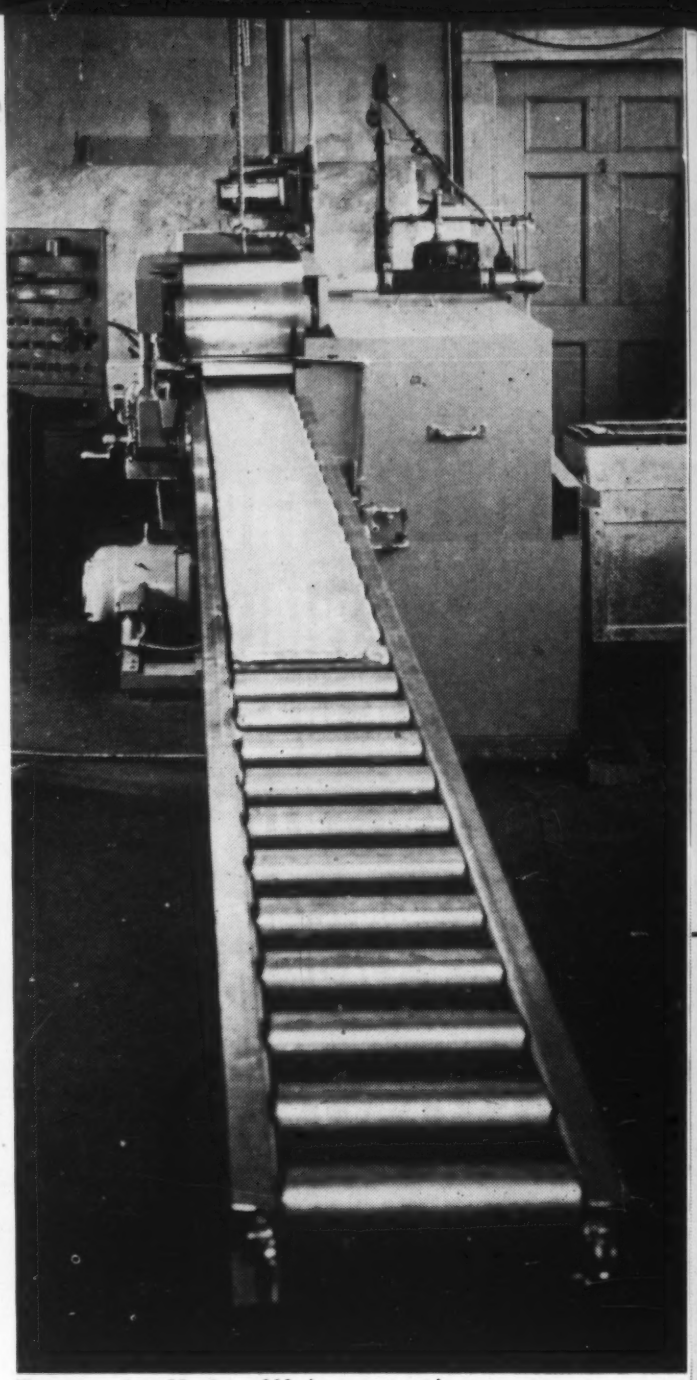
Pure iron whiskers *up to 2 in. long, grown in Westinghouse laboratories exhibit remarkable physical properties.*



Small and compact, *this recent mill is the one that is interesting many strip producers.*



A machine similar to *this 24-in. mill is casting steel strip experimentally.*



Present pilot mill *in operation.*

Continuous-Cast Strip Offers Production Economies

Continuous casting of metal strip—a good idea that previously has never quite worked out—may soon be a commercial reality.

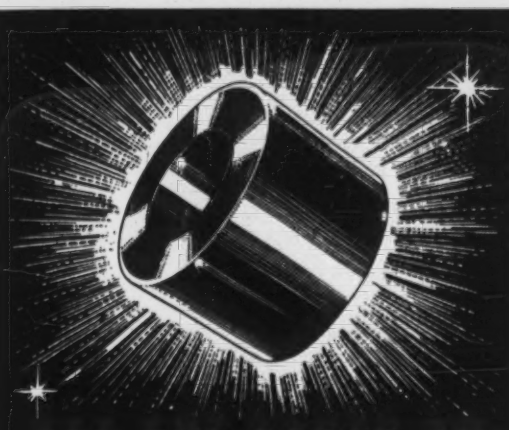
Strip casting got a new lease on life from a machine developed by C. William Hazelett, of Greenwich, Conn. Hazelett has been working on the process for the last 15 years. His machine differs markedly from earlier attempts at strip casting in that the strip is not squeezed between rollers during solidification. As a result, Hazelett claims, the segregation that was characteristic of previous continuous-cast strip is avoided.

Pilot plants in Greenwich, Conn. have turned out continuous aluminum and brass strip. Other companies are working on the process for steel and magnesium. Up to now, experimental units have cast strip as thin as ¼ in., and Hazelett is confident that thicknesses of ⅛ and even 1/16 in. are in the cards.

Both large and small producers of strip seem to be interested in the new process. Several weeks ago, representatives of many such companies saw the mill demonstrated at the Fairfield, Conn. plant of W. S. Rockwell Co. which built the machine in cooperation with Hazelett.

The machine consists essentially of two facing conveyor belts, one above the other and both slightly inclined from the horizontal. The belts are made of thin steel strip and are supported by small rollers in such a way that the facing surfaces are parallel for much of their length. These parallel conveyor surfaces are the principal mold surfaces. The two mold edges are held to the lower conveyor by spring tension and consist of small brass cubes strung together on endless cables. Cooling is provided by a multitude of small nozzles that squirt water against the reverse sides of the belts, and the whole mechanism is mounted over a large water tank.

Briefly, here is how it works. The molten metal is poured continuously onto the lower conveyor which feeds the fluid metal into the moving mold created by the conveyor surfaces in their parallel region. The molten metal is chilled rapidly by the continuously cooled



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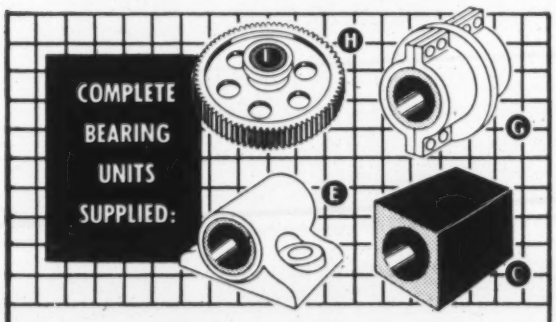

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News Digest

conveyor surfaces and emerges from the parallel mold section as completely solidified strip. A block is inserted across the mold section before pouring to start the strip. Since the emerging strip is nearly horizontal, it can be cut by a flying shear or fed directly into a standard hot mill.

According to Hazelett, the rapid chilling results in metal having fine, uniform grain size and a minimum of segregation. Ingot defects sometimes carried over into rolled strip are, of course, avoided. Edge cracking is also avoided. Surfaces of the cast strip are claimed to excel those of most cast products, especially in the case of aluminum. In actual practice, the cast strip would probably be rolled down to produce thinner gages with a wrought structure.

Accurate control of width and thickness are also claimed. Hazelett says width of the strip can be held to ± ⅛ in. Width can be adjusted by moving the mold edges on the lower conveyor, and thickness can be adjusted by replacing the endless edging by similar edging of the desired thickness. Such adjustments take only a few minutes.

For a given machine, the tonnage production rate for a given metal varies inversely with strip thickness, and the lineal production rate varies inversely with the square of strip thickness. For a given strip thickness, however, it is clear that the speed at which strip of a given metal can be made depends upon the length of the parallel mold section; the longer this section, the faster the solidifying metal can be moved in the linear direction. The length of the Hazelett machine can be tailored to fit individual requirements, and that is why Hazelett says that, for practical purposes, his process has "no upper limit on speed".

Since the molten metal must reach the parallel mold section before solidifying, however, there are definite limits on the minimum speed that can be tolerated. According to Hazelett, these minimum speeds at present are about 20 ft per min for ½ in. strip and 50 ft per min for ¼ in. strip.

The machine itself is small and compact. It could easily be transferred from one melting furnace to another by means of an overhead crane or rails. Power requirements are low, since only enough power to overcome friction of the moving conveyor belts is needed. Maintenance and repair costs also promise to be low.

Continuous casting has many potential advantages over conventional production methods since it eliminates several processing steps and considerable associated equipment. Equipment eliminated would include ladles (where small furnaces are used), ingot molds, ingot stripping and handling equipment, soaking pits and fuel, the blooming mill, and cut-off saws. Processes avoided include ingot stripping, soaking, cropping, chipping, scale-breaking, edging and scarfing. Cost of rolling and rolling mill maintenance would be appreciably reduced. Since lower pouring temperatures are possible, oxidation of aluminum or zinc loss from brass would be reduced.

Composition Standards for Zinc Supplied to Industry, N.B.S.

A plan to supply industry with both laboratory and production quality control standards of zinc base alloy was announced recently by M. D. Cooper of General Motors Research Laboratories Div. These standards, he said, will give industries using zinc base alloys an accurate, basic "yardstick" with which they can compare the composition of any heat or melts they are running in production. Comparison can be made with a spectrograph.

In a paper before the Pittsburgh Conference on Analytical Chemistry and Allied Spectroscopy, Mr. Cooper outlined steps by which General Motors Research Laboratories, the Chicago branch of the National Lead Co. and the

(continued on page 210)

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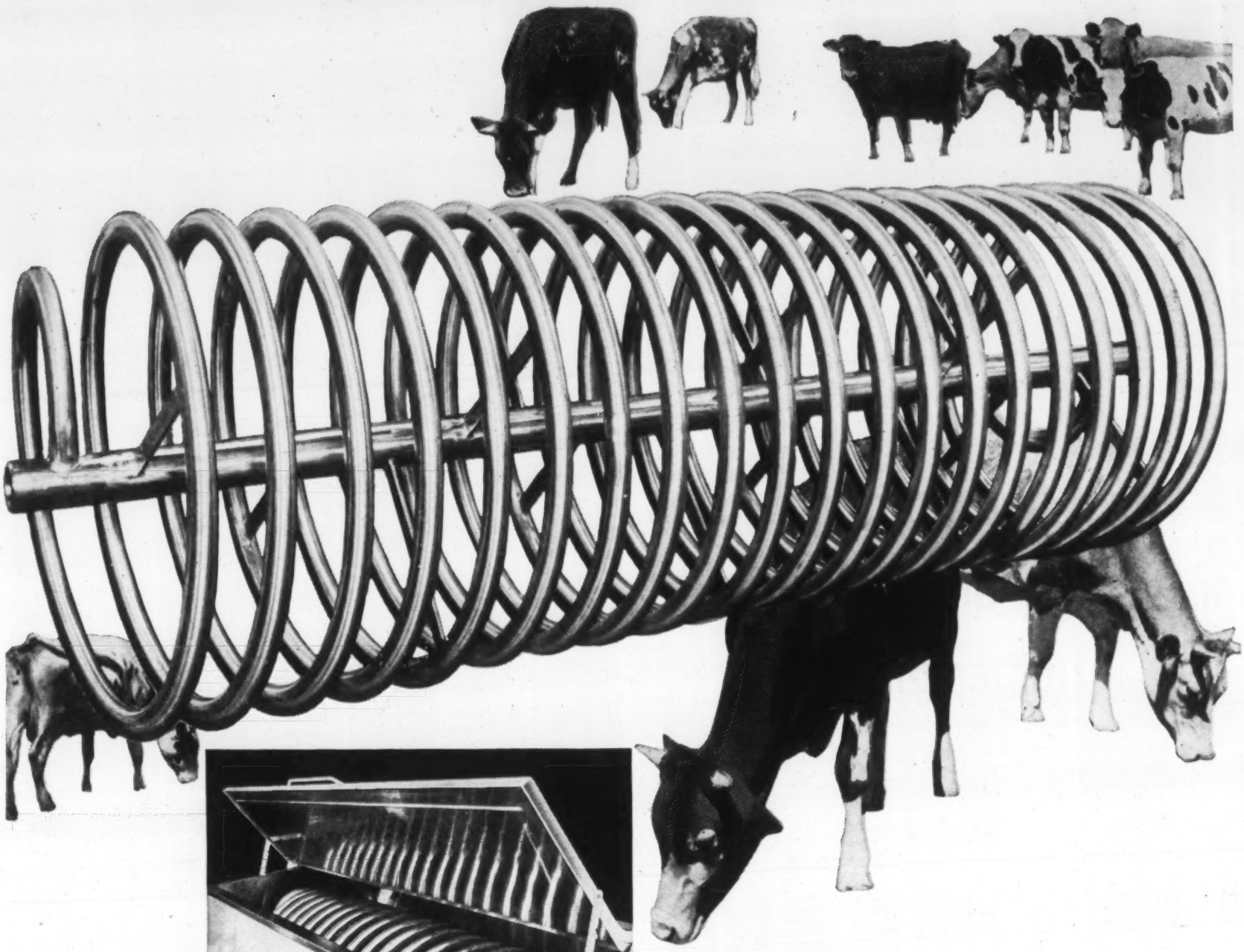

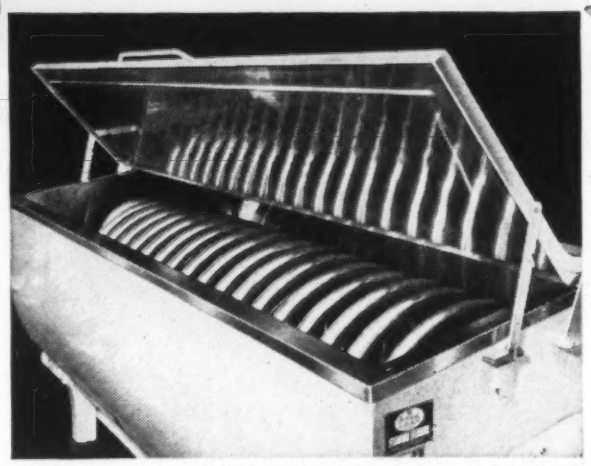

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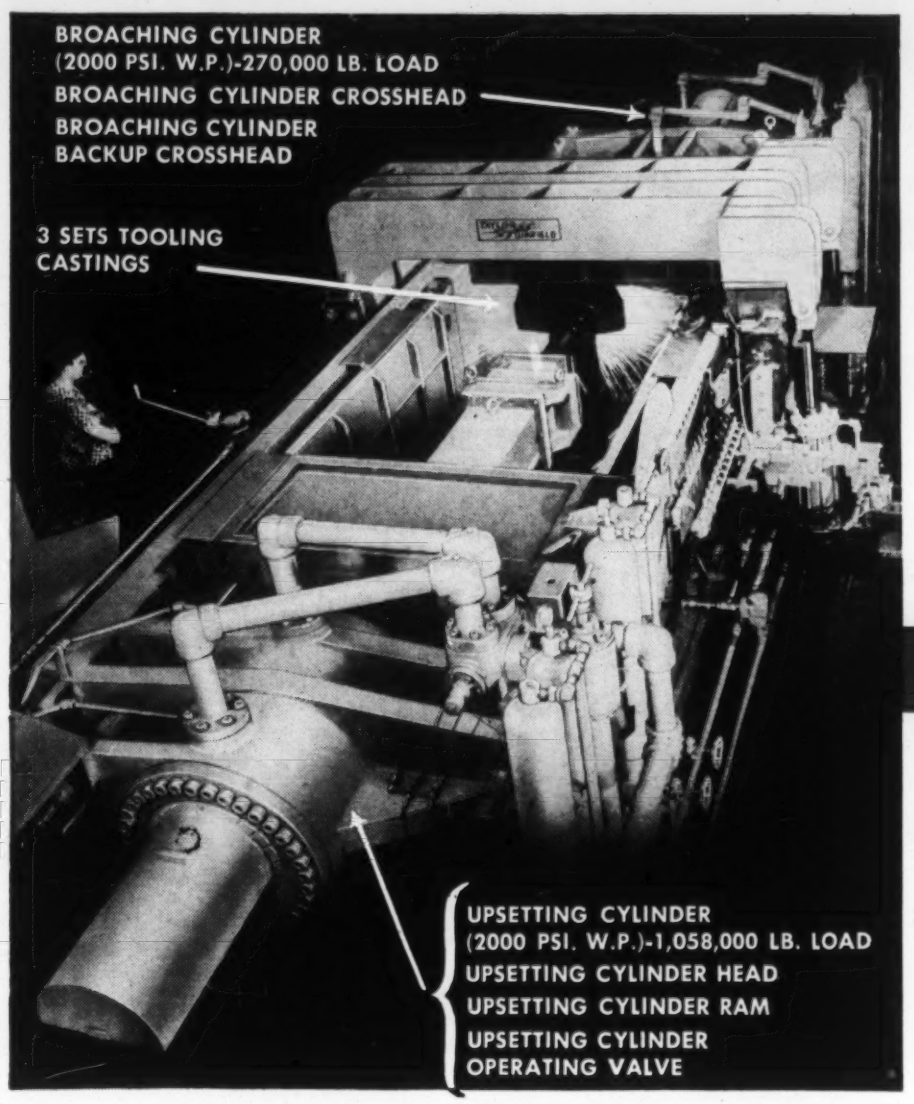


20 TONS OF MEEHANITE CASTINGS IN THIS 500-TON RESISTANCE WELDER

The Taylor-Winfield Corporation, Warren, Ohio engineered and built a 500-ton resistance welder (largest of its kind in the world), for the Cleveland Pneumatic Tool Company. It has an upsetting load of 1,058,000 pounds and a broaching load of 270,000 pounds.

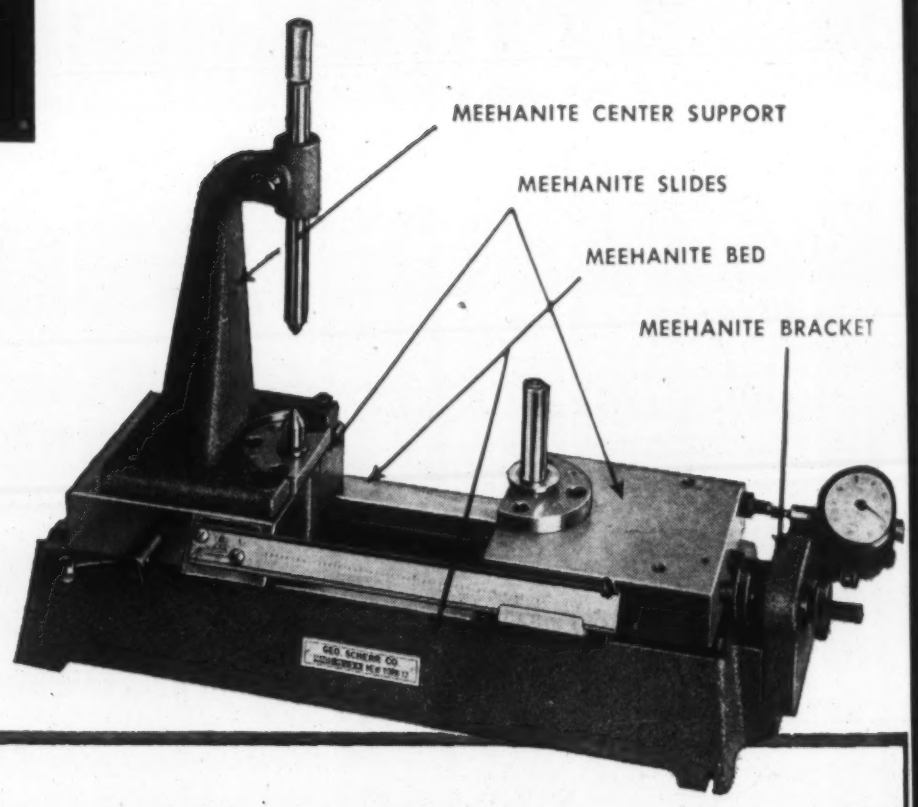
Taylor-Winfield engineers chose Meehanite castings as the heart of this huge welder because of their high strength, their pressure tightness, and their wearing properties. The illustration shows the vital Meehanite parts.

As The Manufacturer Says:

"Due to Meehanite Metal's close or fine grain the machining qualities are excellent and give us better finish and greater strength. Meehanite's heat-treatability gives us better rams for our press welders."

PRECISION INSTRUMENT MANUFACTURER SPECIFIES MEEHANITE CASTINGS

The George Scherr Co., Inc., New York City, manufacturers of precision measuring and testing instruments, has found that insisting upon Meehanite components in the building of their spur gear tester has resulted in greater economy and in the elimination of assembly and fitting problems.



As The Manufacturer Says:

"The production of this testing machine was engineered completely by the use of Meehanite castings. We needed hardened and ground ways in the bed and, similarly, in both slides. If we had provided these by using hardened and ground steel inserts, it would have made the production of the machine much more expensive.

"Instead, we flame-harden both the ways in the bed and the ways at the bottom of the two slides. As a result, we have no extra assembly or fitting problems, and the finishing of all the guide ways is a simple surface grinding operation."

Industries report what Meehanite Castings have done for them

MEEHANITE COMPONENTS IN HYDRAULIC UNIT SEAL ASSEMBLY

The Twin Disc Clutch Company, Hydraulic Division, Rockford, Illinois, is using Meehanite components to improve performance and reduce maintenance.

The seal nose pieces (Fig. 1) for the Fluid Drive Seals are heat treated after machining. They are brought to a heat of 1580-1610 F 6 to 8 hours and packed in fine carburizing compound to prevent decarburization. They are then quenched in oil and drawn at 400-425 F for 4 hours.

It is necessary that the seal surface be ground and lapped flat within 6 wave bands of green-yellow light (.000069") and have maximum profilo-meter reading of 12 micro-inches.

Fig. 2 shows the seal test stand in operation. On the stand are two Torque Converter Seals using Meehanite castings, the oldest having been run for 7,724 hours at 50 psi and 2,500 rpm.

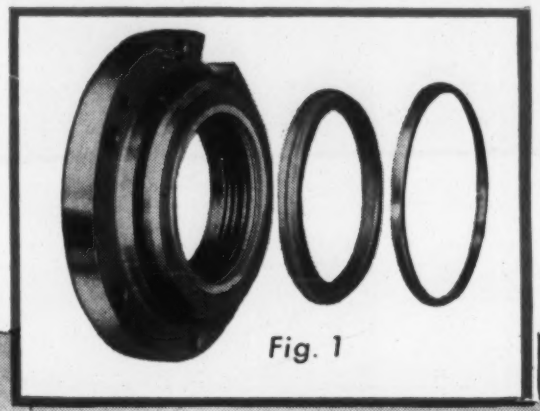


Fig. 1

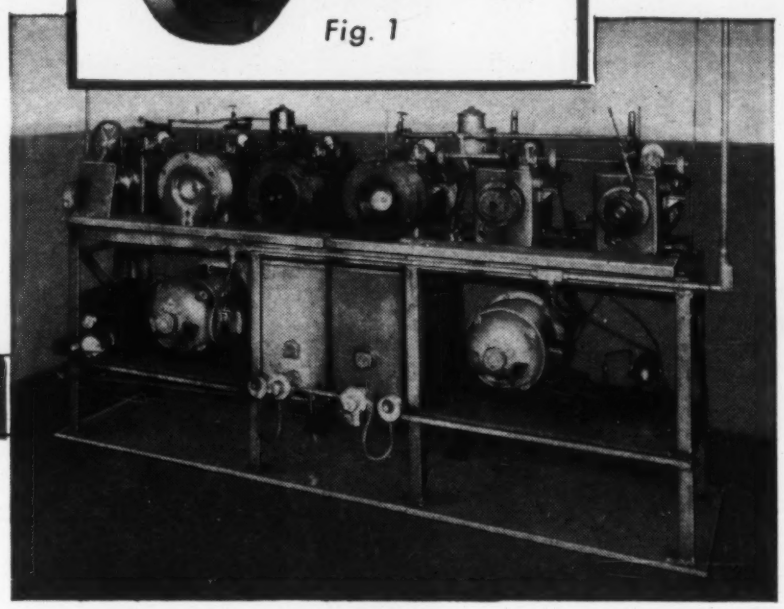


Fig. 2

As The Manufacturer Says:

"Meehanite metal, noted for its high tensile strength, provides many advantages for its use as seals for Twin Disc Hydraulic Torque Converters and Fluid Couplings.

"It has proved to have excellent wear properties and provides very uniform hardness in the heat treating process."

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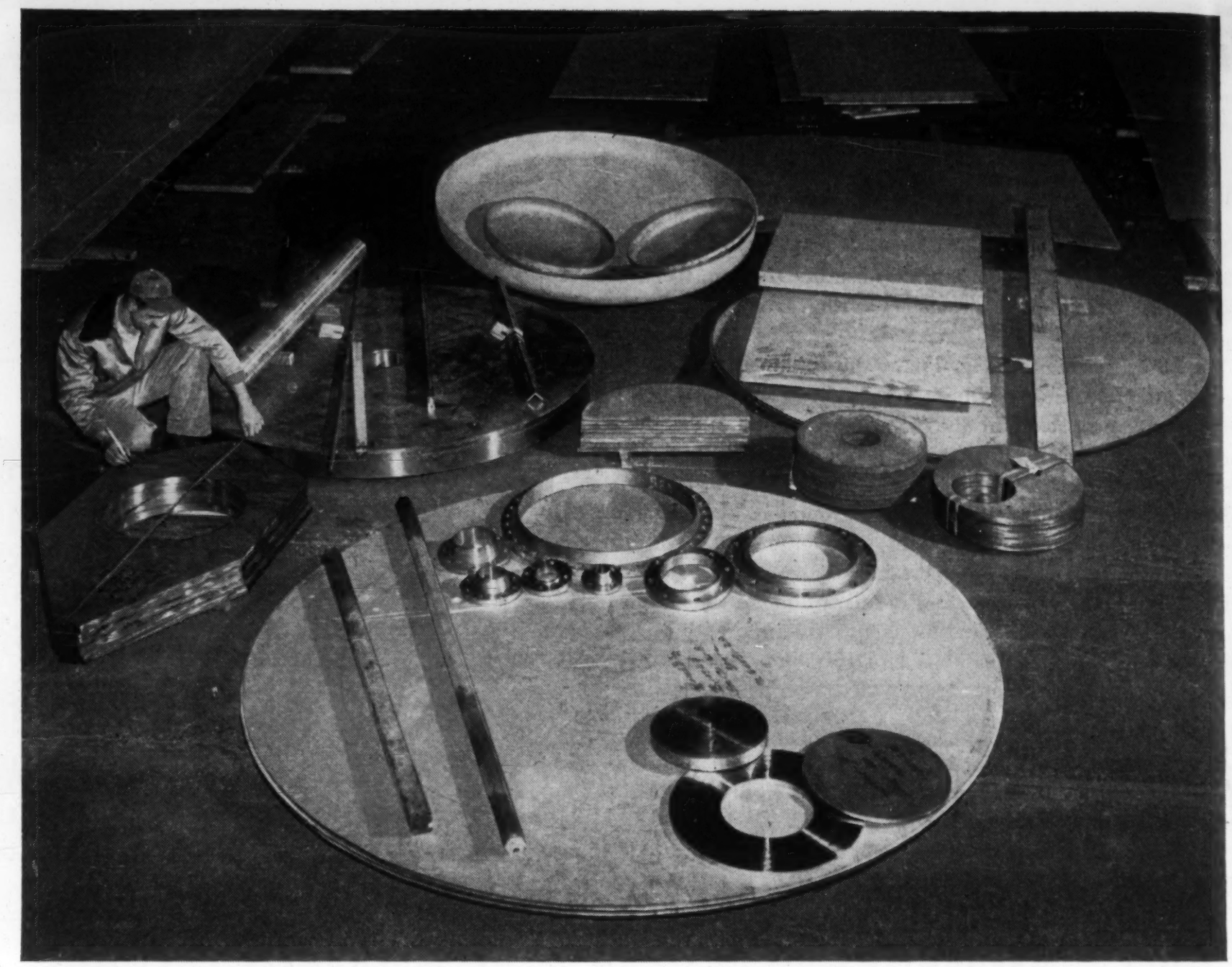

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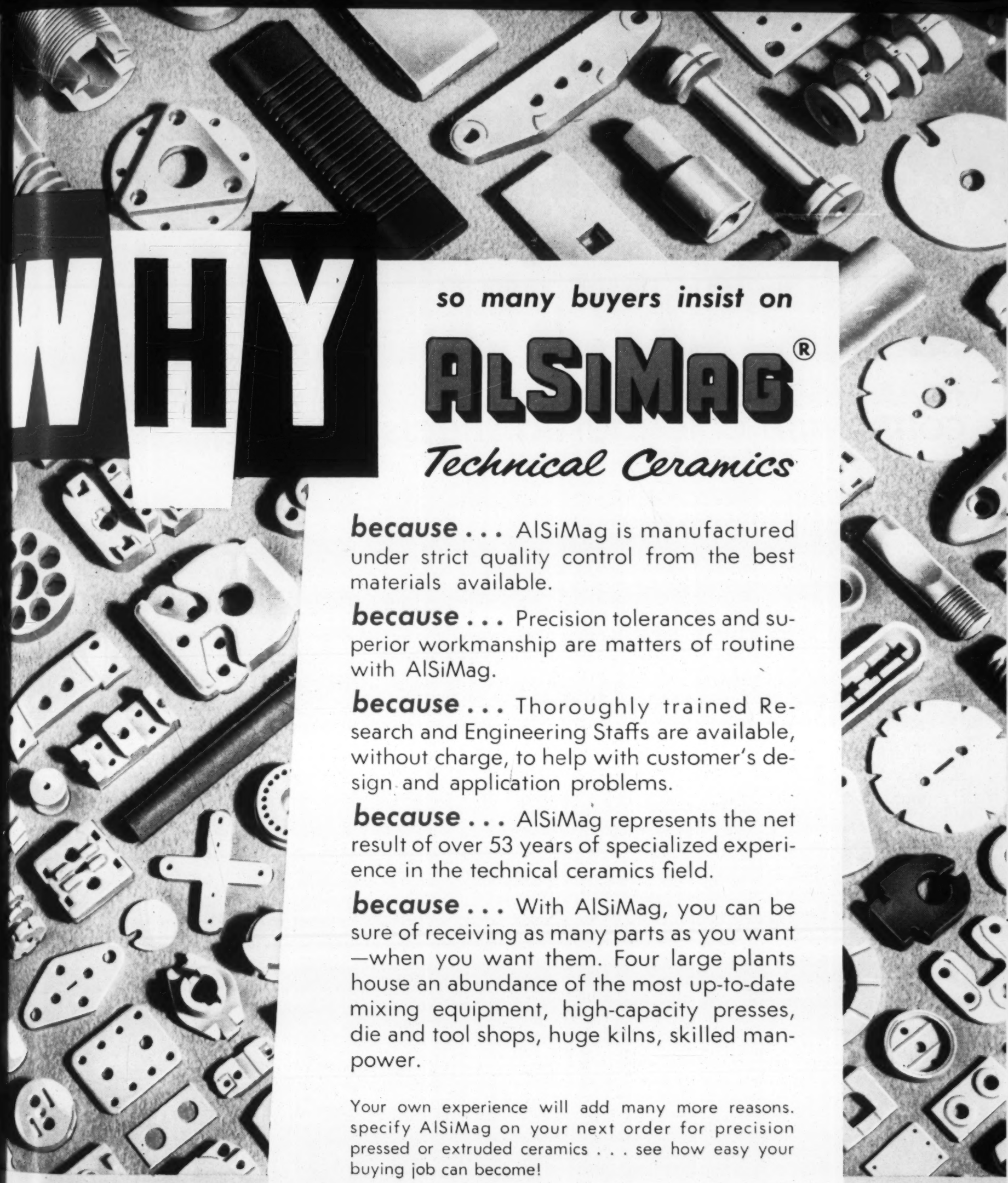

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PLIO-TUF is a unique, high styrene copolymer—a pure, unplasticized resin—not a blend with rubber. It displays not only the usual properties of thermoplastic resins—hardness, stiffness, lightness, warmth and wide color possibilities — but an outstanding resistance to impact and unusual resistance to distortion by heat. Abrasion-, chemical-, electrical- and age-resistance also are above average.

Thicker sheets are possible through lamination of thin sheets. The sheets can be supplied in finishes ranging from highly polished to deep-grain embossed and are easily post-formed by vacuum or mechanical drawing. They are particularly suited to deep-drawing—have been drawn to a depth of nine inches or more without rupture. Once basically formed, they can be further fabricated by drilling, punching, sawing, sewing, cementing, sanding, buffing and painting.

Why not investigate the opportunities presented by PLIO-TUF as soon as possible? Sources of PLIO-TUF sheets plus literature on this versatile resin are yours by writing to: Goodyear, Chemical Division, Akron 16, Ohio.

CHEMICAL GOODYEAR DIVISION

Chemigum, Pliobond, Pliolite, Plio-Tuf, Pliovic—T.M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

The Finest Chemicals for Industry — CHEMIGUM • PLIOBOND • PLIOLITE • PLIO-TUF • PLIOVIC • WING-CHEMICALS

PLIO-TUF ... another quality product of Goodyear Chemical Division

NEW FORM OF PROFITS is this rigid calendered sheet of PLIO-TUF which can be readily post-formed or mechanically fabricated into an endless number of extremely impact-resistant products. Photo courtesy Plymouth Rubber Company, Inc., Canton, Mass.

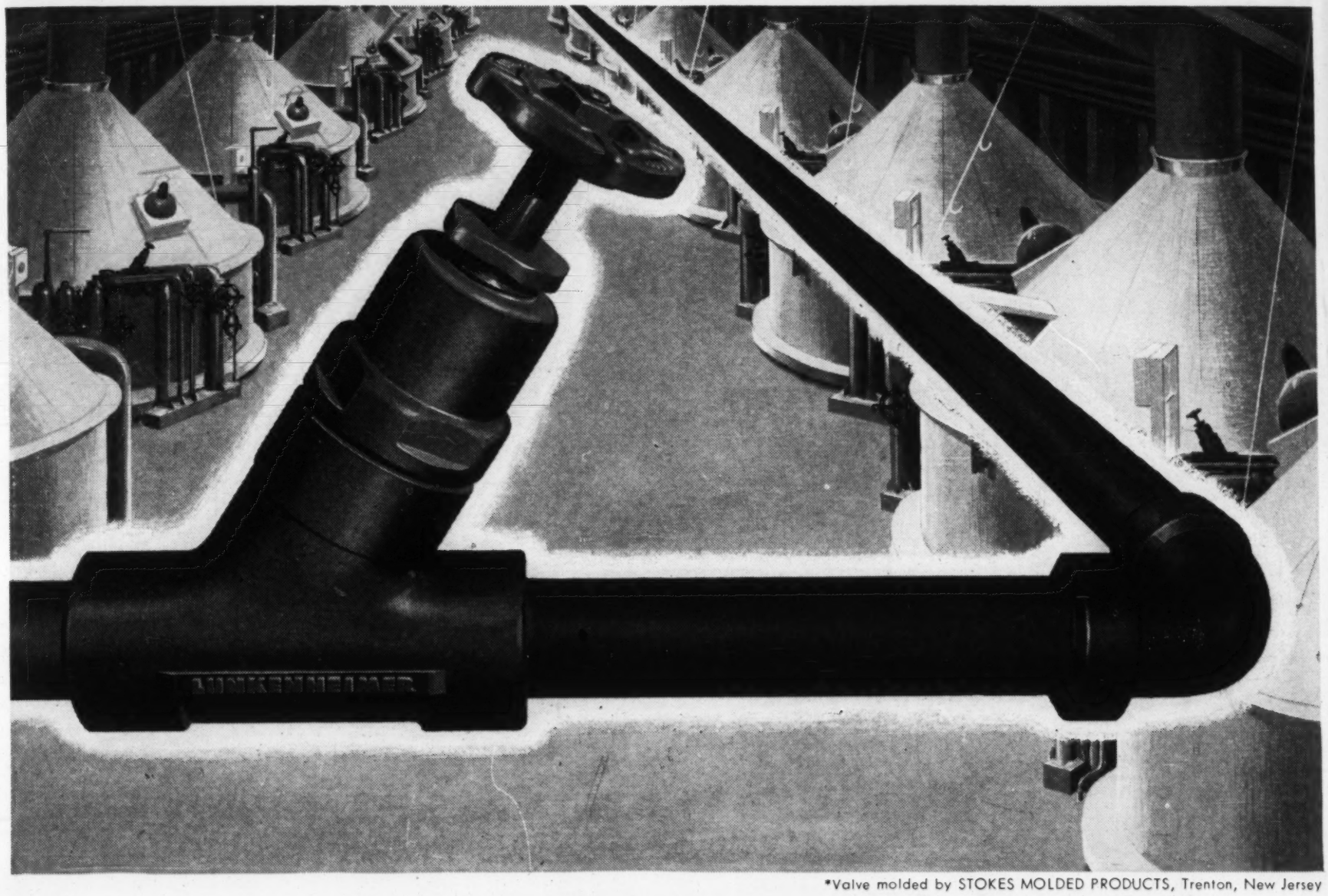
For more information, turn to Reader Service Card, Circle No. 332

EXON: each resin engineered for a specific problem

EXON 402-A

specifically to wipe out

corrosion



*Valve molded by STOKES MOLDED PRODUCTS, Trenton, New Jersey

Millions of dollars are saved every year by American industry as unplasticized rigid PVC made from EXON 402-A wipes out corrosion. It has outstanding resistance to alkalis, acids, inorganic salts, and other corrosive fluids.

It outperforms, yet costs less than customary metals in many industrial applications. A tremendously important application, pictured above, is the new LUNCOR VALVE* engineered by The Lunkenheimer Co. It is the first all-molded PVC valve designed by a valve manufacturer.

Easier and less expensive to work with, unplasticized PVC made from EXON 402-A is strong but extremely lightweight compared with most metals. EXON 402-A is unusually versatile. It can be made into sheets, rods, tubes and other structural shapes. These can be cemented or welded... and are readily sawed, sheared, stamped, milled, drilled, planed and rolled on conventional metal or woodworking equipment.

For complete information or technical service on EXON resins, call or write Firestone.

Firestone

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CHEMICAL SALES DIVISION

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DIVISION OF FIRESTONE TIRE & RUBBER CO.

For more information, turn to Reader Service Card, Circle No. 309

For more information, Circle No. 458 ➤

50-ton crane becomes 85-ton crane

with no increase in size

United States Steel's Edgar Thomson Works in Braddock, Pennsylvania, needed new and heftier crane equipment to handle larger ladles. One requirement was four new crane trolleys which were to operate on the same bridges, if possible, and in exactly the same clearances as before.

The trolleys had to be stronger but no larger than before; so ordinary steel wouldn't do. Needed, was a steel of *exceptional strength* which could be *welded easily*. Lots of alloy steels could have met the strength requirements; but USS "T-1" Steel was the *only* steel that could supply not only the required strength, but good weldability as well.

"T-1" Steel plate—in ¾" and 1" thicknesses—was used in box girders and lateral stiffener plates of the trolleys. This change increased the crane capacity from 50 to 85 tons with no increase in size.

The structure was welded with AWS E12015 electrodes. It was as easy as welding carbon steel. No stress relief was needed. And the welds developed the full yield strength of the steel: 90,000 psi. minimum.

Remember this story when you must weld very high strength parts —parts that must operate at temperatures as high as 900°F. or as low as 40°F. below zero, parts that must withstand tremendous impact abuse, abrasion or tensile stress. Then consider USS "T-1" Constructional Alloy Steel. For full particulars write: United States Steel, Room 4770, Pittsburgh 30, Pa.

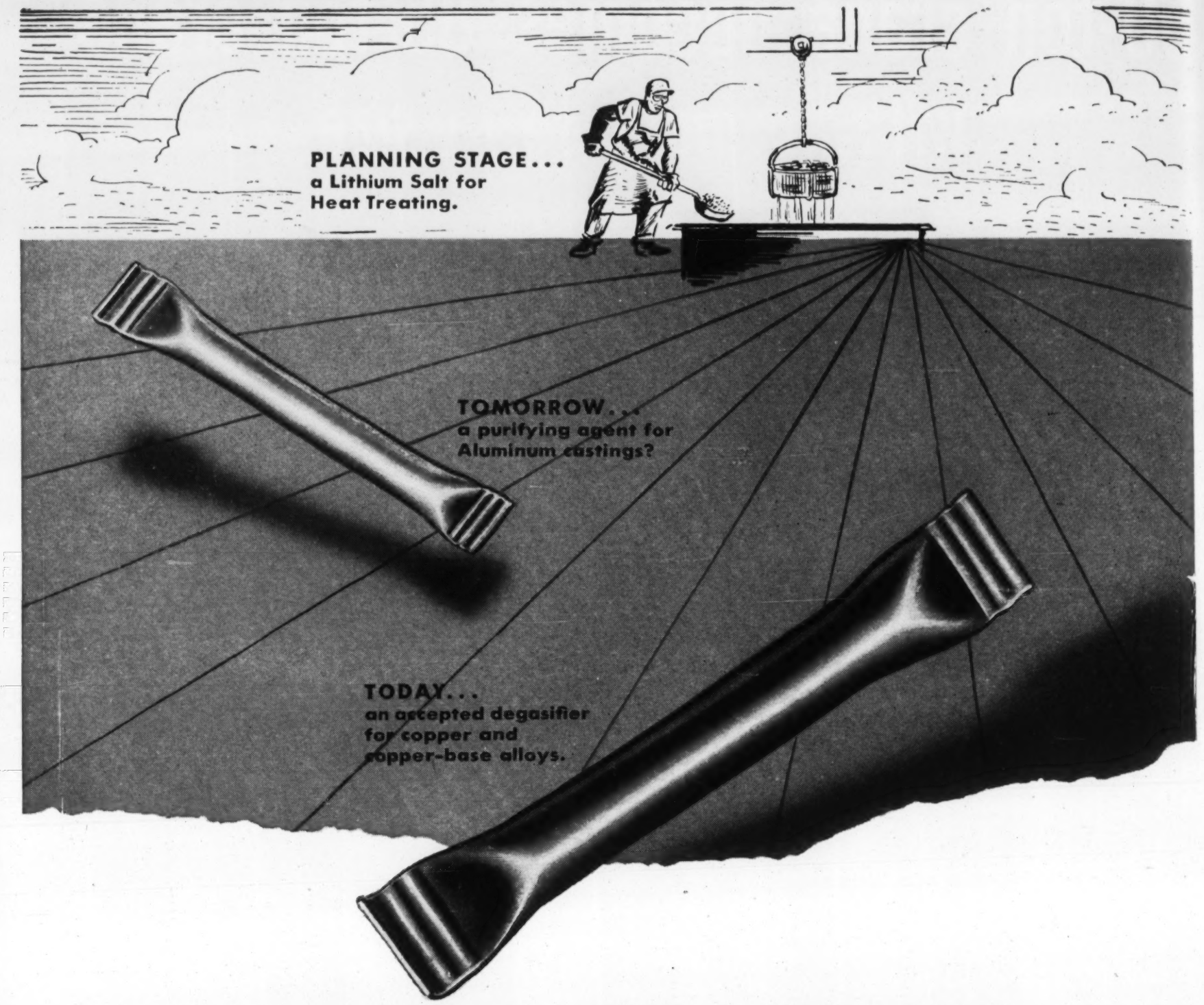
UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

USS TRADE MARK

UNITED STATES STEEL



LITHIUM METALLURGY

Lithium has been long established in the nonferrous foundry industry as a degasifier, deoxidizer, desulfurizer and general purifying agent. The small amounts required put both the economics and technique within the limits of everyday nonferrous foundry operation. Now, tests under certain production conditions indicate that Lithium is equally valuable as a degasifier for aluminum castings. Still in the realm of research, Lithium Salts hold vast promise of valuable benefits for low temperature heat treating baths. Why don't you look into this miracle element? This revolutionary technique is within *your* reach. Write for the details.

... trends ahead in industrial applications for Lithium

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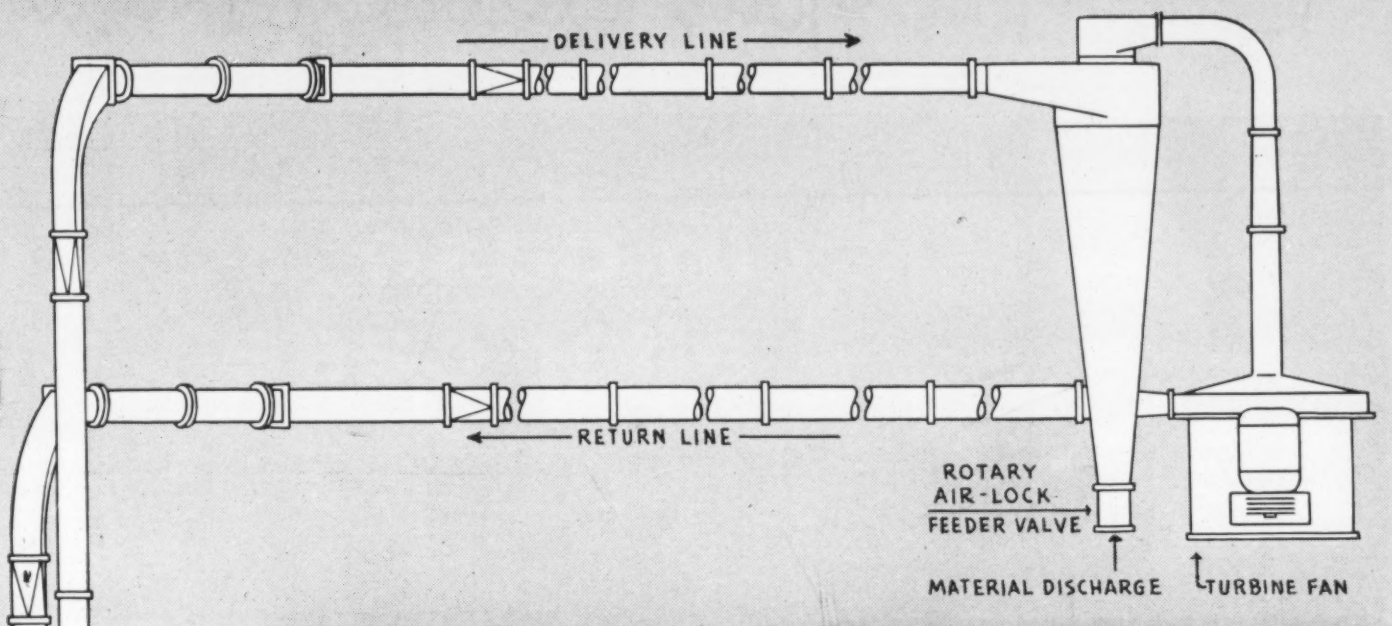
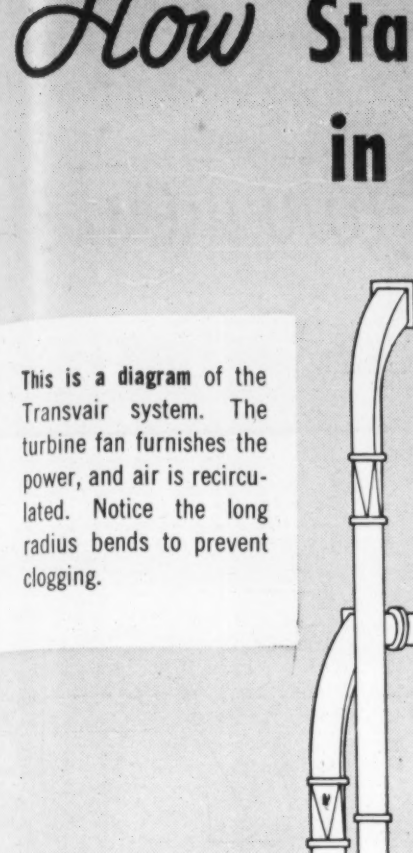
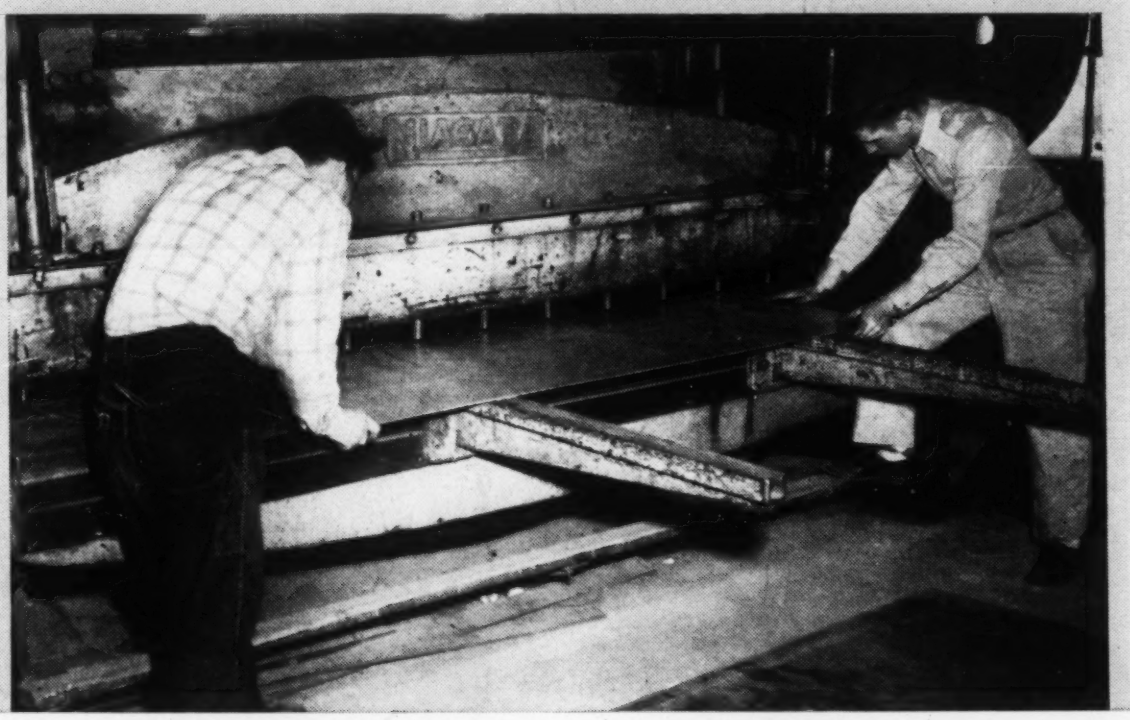
For more information, Circle No. 470 ➤

How Stainless Steel prevents contamination in pneumatic transfer system



This is a diagram of the Transvair system. The turbine fan furnishes the power, and air is recirculated. Notice the long radius bends to prevent clogging.





Stainless Steel presents no fabricating problems at Young Machinery Company. This standard shear, for example, is used to cut both ¼" carbon steel and 10-gauge Stainless Steel.

Young Machinery Company makes a unique line of air conveyors that transfer dry, free-flowing materials through tubing. Energy is furnished by a turbine fan, and the entire system is sealed so that hazardous and toxic substances can be handled with safety.

Since contamination is a problem, the systems are frequently made from Stainless Steel. The first time that Young used this metal was in 1949, but now it accounts for 50% of their total production.

These systems are frequently used to move corrosive solids in the chemical industry — a natural use for Stainless Steel. Then, too, foodstuffs are often handled; and the dense, easy-to-clean surface of Stainless Steel is unmatched for this service.

There have been no production difficulties. Identical equipment is used for fabrication of Stainless Steel or carbon steel. In fact, it was not necessary to buy new equipment or even modify the older machinery when Stainless Steel was used.

No other metal combines the easy fabrication, corrosion resistance, high strength and cleanliness of Stainless Steel. If you plan to use this durable metal, remember that United States Steel has the nation's largest assortment of Stainless Steel shapes, sizes, types and finishes.

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COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
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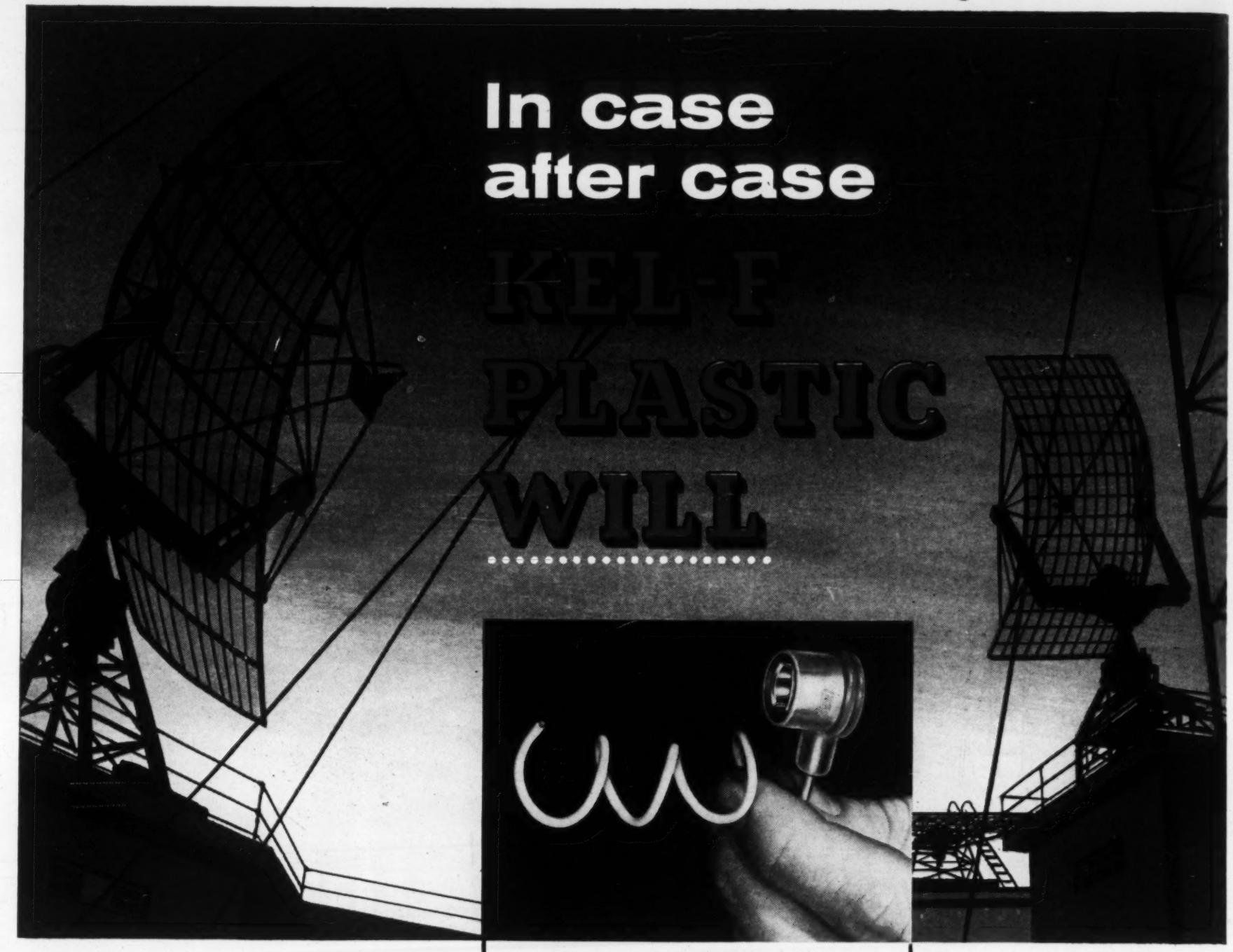
USS

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

When No Other Material Can Meet Your Electrical Requirements



New tube cap connector made of KEL-F Plastic insures high insulation resistance, and excellent dimensional stability over a wide temperature range (—320° to 390°F.) for critical installations.

KEL-F® PLASTIC *IS* UNIQUE. A polymer of trifluorochloroethylene, its molecular construction produces a combination of outstanding properties headed by excellent electrical characteristics, resistance to chemical attack and negligible deformation under load.

KEL-F Plastic is dense, tough, and readily moldable. It has an operational temperature range of approximately 710° F. (—320° F. to 390° F.) KEL-F Plastic is non-wettable, and moisture absorption is zero! In electrical applications it can be used structurally as well as dielectrically—particularly in the critical electronic applications encountered in sub-miniaturization, automation, servo-mechanisms, etc. And, as wire insulation, KEL-F Plastic offers outstanding abrasion resistance, so important in aircraft and other critical installations.

KEL-F Plastic is available as a molding compound, or in extruded film, sheeting, rods and tubing from independent fabricators. KEL-F Dispersions for bake-coating of metallic surfaces are also obtainable. The complete story of KEL-F Plastic should be in your "ready" file. Write for special bulletins.

KELLOGG

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Chemical Manufacturing Division, P. O. Box 469, Jersey City, N. J.
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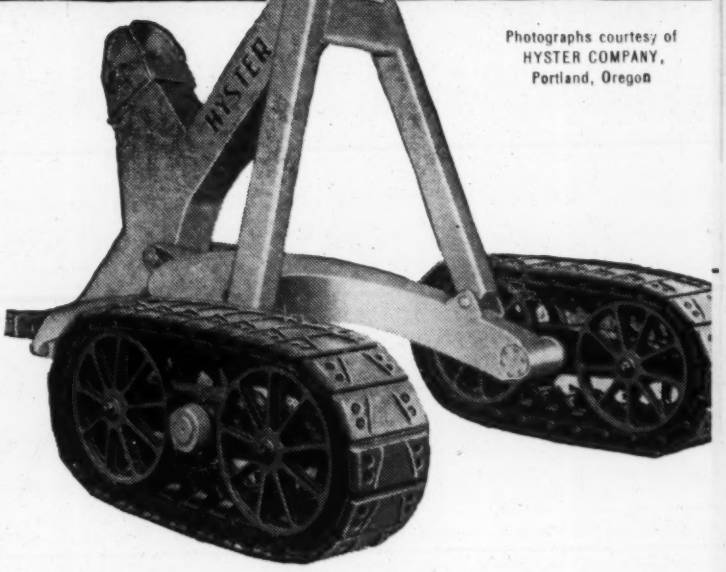
For more information, Circle No. 423 ➤

Built stronger, tougher and lighter with USS MAN-TEN Steel

Famous HYSTER Logging Arch handles more footage faster



Photographs courtesy of HYSTER COMPANY, Portland, Oregon

In this "packaged" logging unit, consisting of a Hyster Arch Towing Winch and Caterpillar Diesel Tractor, the objective of the engineers was to produce equipment having the highest degree of mechanical efficiency, plus durability and speed of operation.

Because the key to profits is greater log production, which means that unnecessary breakdowns must be eliminated, extra margins of safety have been built into all parts subjected to stresses and wear.

By using USS MAN-TEN High Strength Steel in the arch boom, A-frame and tongue, it was possible to reduce weight of these important members by 10%, and yet to *increase* their strength-to-weight ratio over former construction.

The increased strength provided by MAN-TEN Steel gives the arch the ability to handle log loads of maximum size, and the reduced arch weight means greater mobility and maneuverability. Result: The operator can get into tight spots easier and pick up loads faster. Reduced weight also permits greater grade climbing ability in steeper terrain.

With USS High Strength Steels — USS MAN-TEN, USS COR-TEN and USS TRI-TEN—you can build extra strength and toughness into vital parts and ensure greater resistance to wear, fatigue, abrasion and impact.

NOW AVAILABLE . . . Our new "Design Manual for High Strength Steels" is ready for distribution. This excellent book contains comprehensive and practical information that you will find extremely useful in designing your product for greater economy and efficiency by the sound use of high strength steels.

For your free copy, write on your company letterhead giving your title or department, to United States Steel Corporation, Room 4776, 525 William Penn Place, Pittsburgh 30, Pa.

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USS MAN-TEN HIGH Strength STEEL

USS

See "THE UNITED STATES STEEL HOUR"—Televised alternate weeks—Consult your newspaper for time and station.

5-1028

UNITED STATES STEEL

To cut forging costs . .

WHENEVER a customer for aluminum forgings submits a design to Kaiser Aluminum's Erie Forging Plant, our engineers study it closely to see if we can lower costs, improve the design, or both.

And time after time, this second look results in big savings for customers on dies and pieces. Here are a few typical examples . . .

If you are now buying aluminum forgings, let our engineers review your designs with a view to effecting savings like those illustrated here.

If you have not yet converted to aluminum forgings, why not investigate now? Our engineers will be glad to work with you to help you get a better product at lower cost.

Take advantage of Kaiser Aluminum Forging Consultation Service without delay. Contact any Kaiser Aluminum Sales Office listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office,* Palmolive Bldg., Chicago 11, Illinois; *Executive Office,* Kaiser Bldg., Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service

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s . . think of *Kaiser Aluminum*

Case A

Die cost if made per customer blueprint submitted for bid . .	$16,395
Die cost when made per blueprint of Kaiser Aluminum Forging Engineers	$12,255
Cost Saving . . .	$ 4,140
Piece price if based on customer's design	$ 59.65
Piece price based on design of Kaiser Aluminum Forging Engineers	$ 54.56
Saving per piece . .	$ 5.09

Case B

Die cost (including set-up time) if made per customer blueprint submitted for bid	$17,040
Die cost when made per blueprint of Kaiser Aluminum Forging Engineers	$13,600
Cost Saving . .	$ 3,440

Case C

Die cost if made per customer blueprint submitted for bid .	$ 1,315
Die cost when made per blueprint of Kaiser Aluminum Forging Engineers	$ 885
Cost Saving . . .	$ 430
Piece price if based on customer's design	$ 2.33
Piece price based on design of Kaiser Aluminum Forging Engineers	$ 2.09
Saving per piece . .	$ .24

To Change the *Style*
Change the STEEL
Switch To Sharonart

The name SHARONART identifies Rolled-in design patterns produced by Sharon Steel Corporation and Divisions.

SHARONART offers texture patterns to the appearance designer. Usually it has been necessary for the manufacturer to combine another material with steel to obtain such finishes.

This textured material can be fabricated by any usual steel processing methods.

Complete flexibility of design is available with SHARONART. Any repetitive design you prepare can be reproduced on steel.

Investment in one pattern is relatively small. Changes in your product's apperance are simple to arrange.

Technical advice and assistance are available to customers wishing to adopt this new material.

A brochure giving complete information of our sizes, pattern designs and numbers, product uses, pictures of designs and products made from SHARONART steels and methods of fabrication is available (see coupon).

SHARON STEEL CORPORATION
Sharon, Pennsylvania

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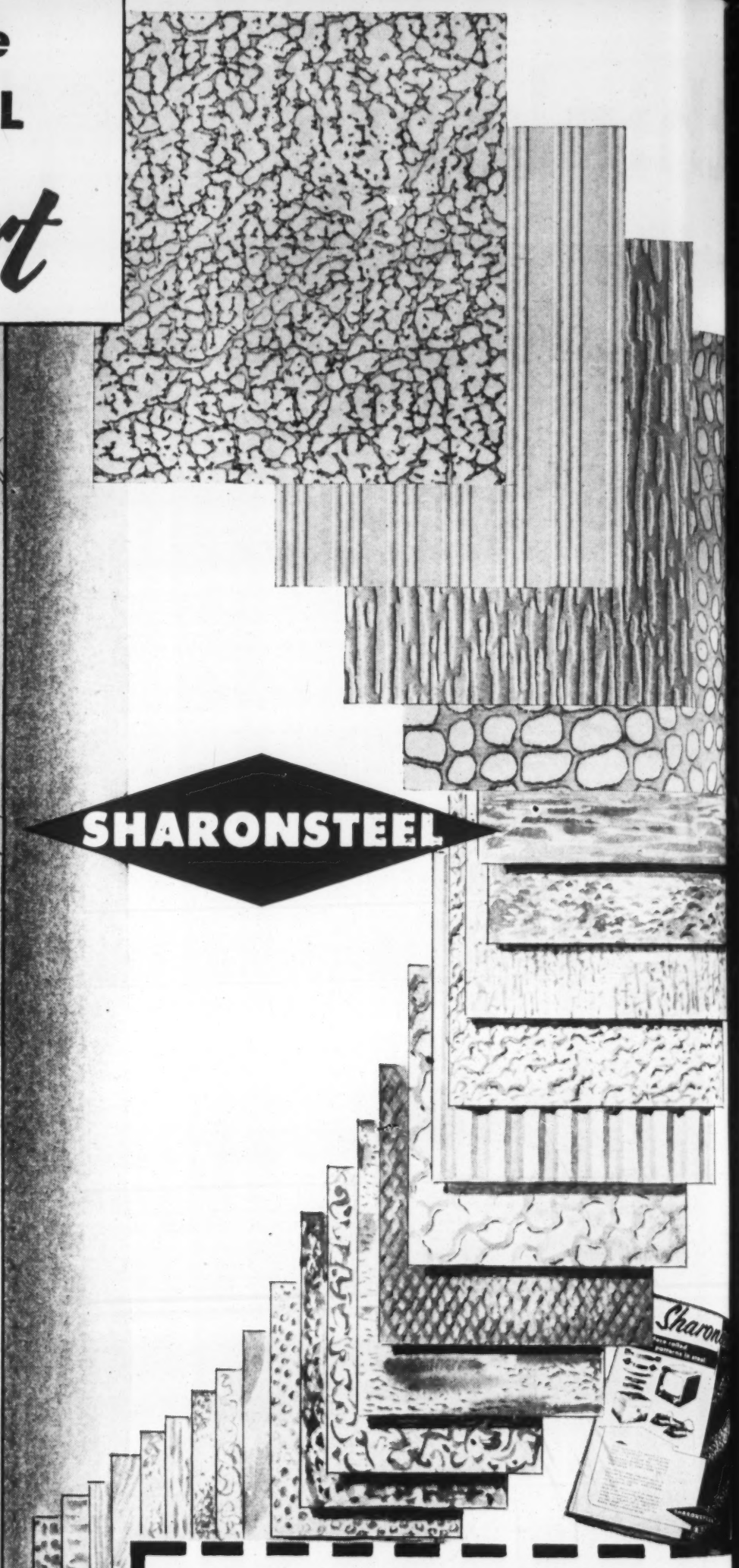

SHARON STEEL CORPORATION
Sharon, Pennsylvania

Please send "SHARONART surface rolled patterns steel.

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Company _____

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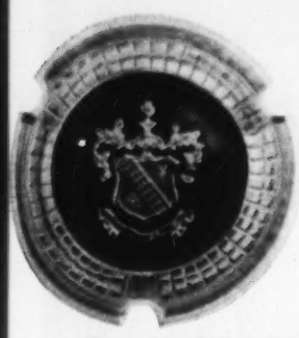
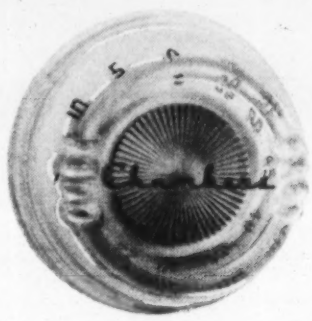
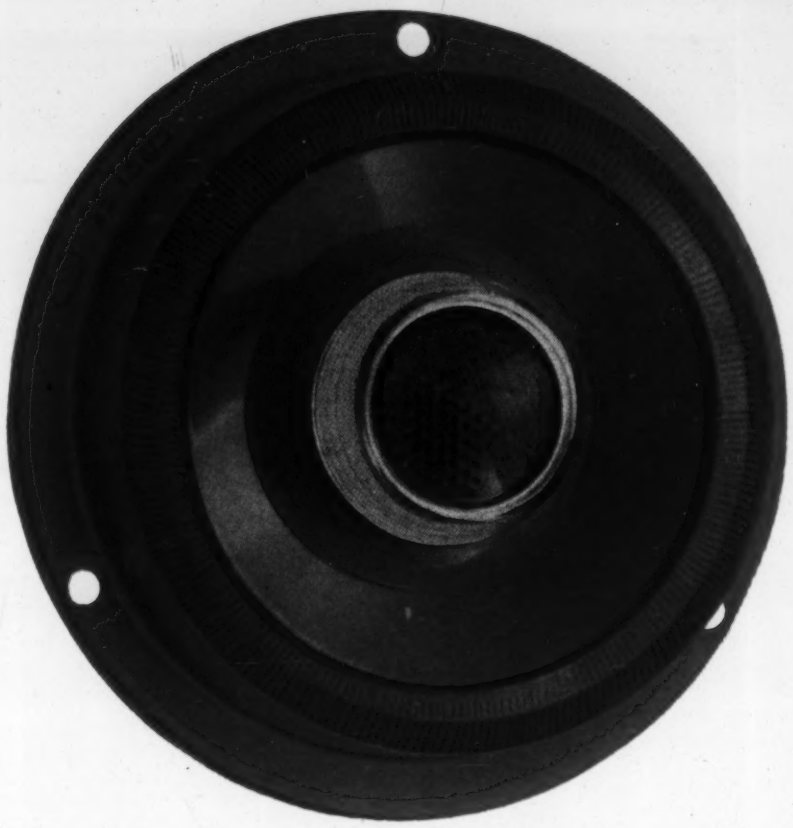
Freezer Door Panel



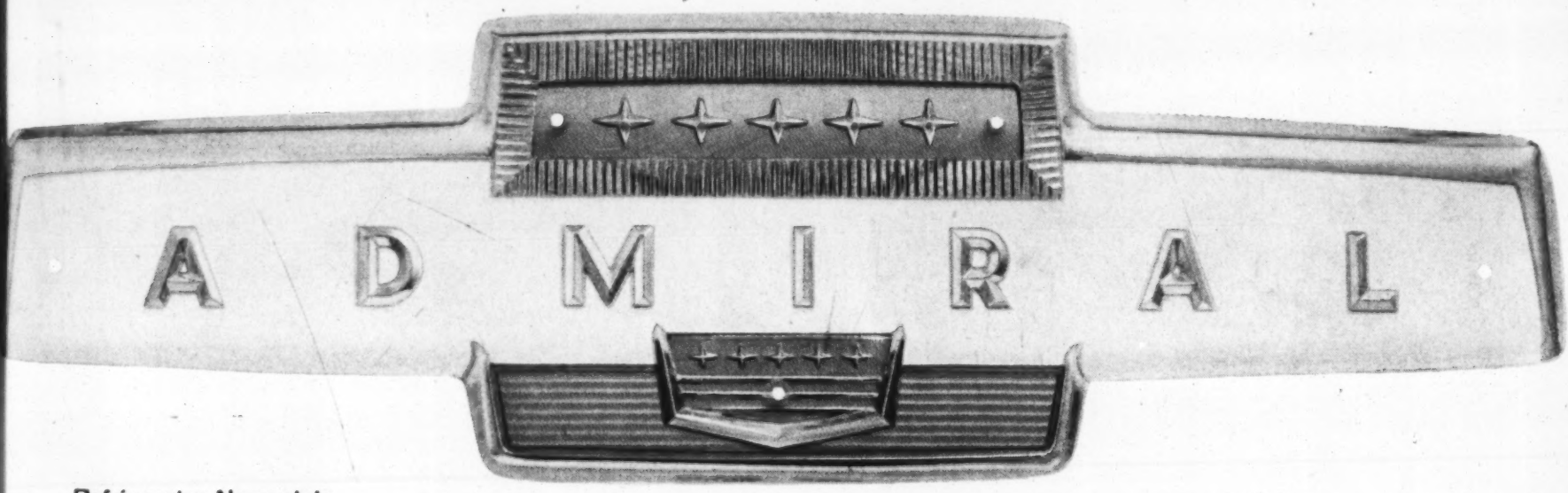
Steering Wheel Cap



Range Control Knob



Tail Light Lens



Refrigerator Nameplate

Plexiglas ...the distinctive touch for fine products

Molded parts like those shown above combine functional value with gleaming beauty because they are made of PLEXIGLAS. This acrylic plastic has outstanding resistance to breakage, discoloration, weather and corrosion.

The combination of rich, brilliant appearance and rugged durability is the reason PLEXIGLAS acrylic plastic is chosen by manufacturers to give added sales appeal and serviceability to their products. You find parts molded of PLEXIGLAS, for example, on cars, home appliances, outdoor lighting fixtures, optical equipment and industrial pumps. Our brochure "Molding Powder Product Design" tells how and where to use PLEXIGLAS. We would like to send you a copy.

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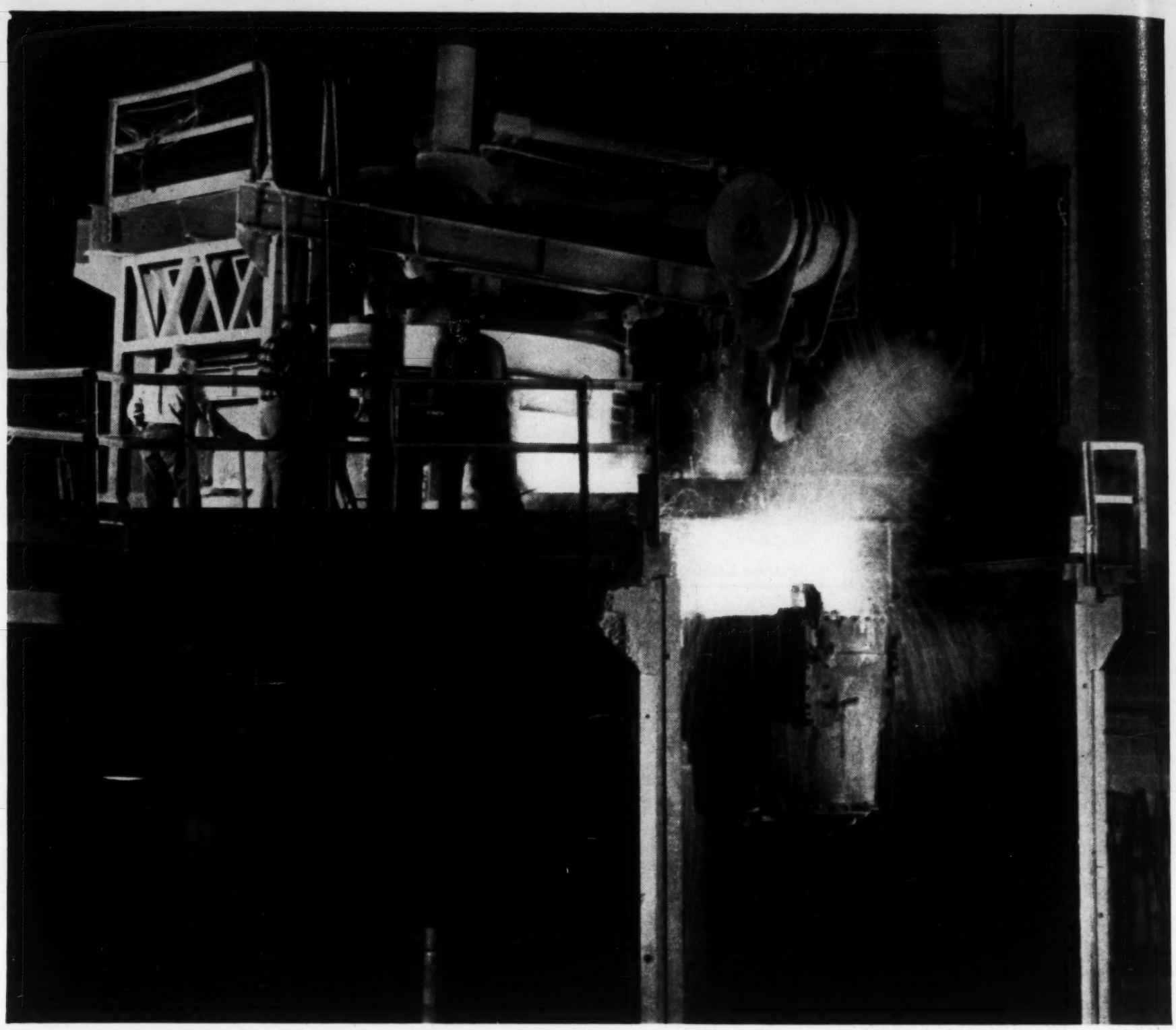
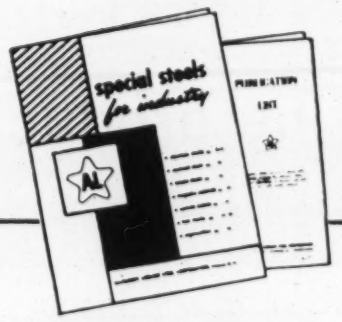


Can we pour a "cup" for you?



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Somewhere in your setup, there's a spot where one of our special alloy steel products (stainless or heat-resistant, tool or electrical) can be used to gain you a real advantage. *Right now!* It might come from reduced production, maintenance or depreciation costs. Or it might come from increased sales appeal: gaining an edge on competition in beauty, strength, service life or performance. The advantage is *there*—and our Research and Engineering Staffs are ready to help you find it. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

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HIGH-ALLOY STEELS

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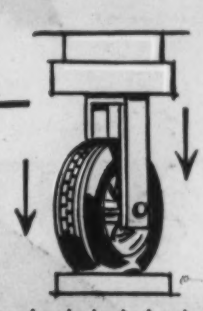
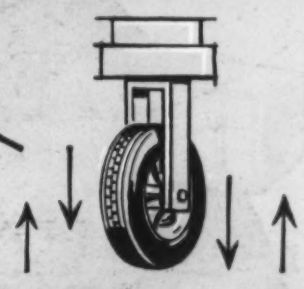
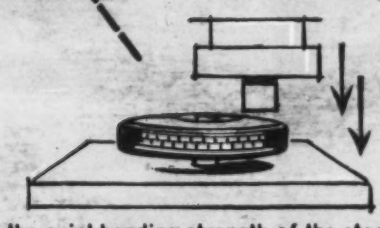
Recent independent laboratory tests on lawn mower wheels* showed:



The Kralastic wheels tested actually had 5% more usable strength than conventional steel lawn mower wheels!



The impact strength of the Kralastic wheels was practically identical with that of the steel wheels!



And the axial bending strength of the steel wheel was only 16% greater than that of the Kralastic wheel!

These tests—made by an independent laboratory for Michigan Molded Plastics Co.—demonstrate clearly the amazing strength Kralastic wheels offer.

Even more important, though, are the many other advantages Kralastic gives wheels. An unusual rubber-resin blend with a unique combination of hardness *and* toughness, high dimensional stability, and reliable performance over a wide temperature range, Kralastic produces wheels that are...

- self-lubricating and practically wear-proof
- rust-proof—corrosion proof
- attractively, permanently colored
- less than half the weight of aluminum
- highly resistant to abrasion
- easily assembled—require no bearings
- *relatively inexpensive!*

Why not consider the many opportunities for improved product performance and *increased sales* Kralastic® offers you? *And feature these advantages.* They will help you sell the complete product. For further information, write us on your company letterhead *today.*

*Kralastic wheels, manufactured by Michigan Molded Plastics Co., Dexter, Mich.

NAUGATUCK

Division of United States Rubber Company
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from tumblers to trailers...get the most

ALUMINUM

Photograph shows 1700-ton hydraulic press in operation at a Reynolds plant. Work in progress is one of the largest drawn aluminum parts ever made—a one-piece 12' x 4'8" hull for an aluminum boat. This press is currently producing other drawn parts 6' in diameter.

REYNOLDS ALUMINUM

BLANKING · EMBOSSING · STAMPING · DRAWING · RIVETING · FORMING · BRAZING

ost

from your designs with

M PRESS PARTS

from REYNOLDS

Square corrugated trailer siding is being fabricated here on a brake press. Brake presses from 22½ to 300 tons are available for your requirements by Reynolds Aluminum Fabricating Service.

Washing machine tubs being fabricated here are one example of countless quality parts that can be produced to your specifications by Reynolds Aluminum Fabricating Service.

Here is part of a battery of medium presses in a Reynolds plant. Large, medium or small—Reynolds Aluminum Fabricating Service has presses to fit your every need.

If your designs call for aluminum parts that require blanking, punching, drawing, forming, stamping, piercing or other press operations, Reynolds Aluminum Fabricating Service can produce these parts to your specifications quickly, efficiently and economically.

The great variety of Reynolds specialized equipment permits you to obtain the economy of the machines best suited to your purpose without making the tremendous capital investment in equipment and added plant capacity which would otherwise be required. Reynolds quality control from mine to finished product and Reynolds experienced design and engineering service go hand in hand with these facilities to assure you the most from your designs.

In two plants alone, out of the more than 30 Reynolds plants in 18 states, Reynolds offers 128 presses including mechanical presses from 2 to 1700 tons and hydraulic presses from 300 to 5000 tons. Reynolds can furnish press parts from simple blanks to deep drawn parts of large area; from very thin to the thickest aluminum that can be drawn.

For full details on these operations and on the many other services offered by Reynolds Aluminum Fabricating Service, call the Reynolds office listed under "Aluminum" in your classified telephone directory or write *Reynolds Aluminum Fabricating Service, 2060 South Ninth Street, Louisville 1, Ky.*

FREE:

Write for your copy of the 24-page "Catalog of Facilities." Get full details on the tremendous production facilities of Reynolds Aluminum Fabricating Service.

See Reynolds "Do-It-Yourself" program, Sunday nights on NBC-TV

M FABRICATING SERVICE

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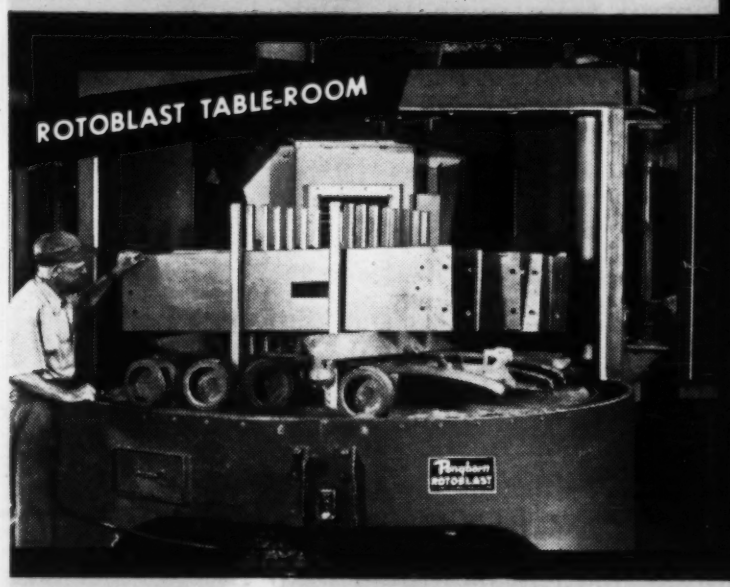
Faster...

better...

cheaper...



Faster, better, cheaper—these are no empty claims. There are sound reasons why Pangborn Rotoblast offers these benefits. Rotoblast gives you faster blast cleaning because it throws a greater volume of abrasive over a specific area in less time. It does better cleaning because its cleaning action is uniform, scouring surfaces to a bright, gleaming finish. It cleans cheaper because, in addition to speed, Rotoblast saves labor costs and requires less power to operate. (Rotoblast is versatile, too, handling all kinds and sizes of products!) Investigate Pangborn Rotoblast now!

that's blast cleaning with Pangborn Rotoblast®!

Send for free copy of Bulletin 214 today! The few minutes you take to write can save you thousands of dollars annually. Write PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment.*

For more information, Circle No. 367

Pangborn

BLAST CLEANS CHEAPER

Rotoblast Blastmaster® & Continuous-Flo Barrel

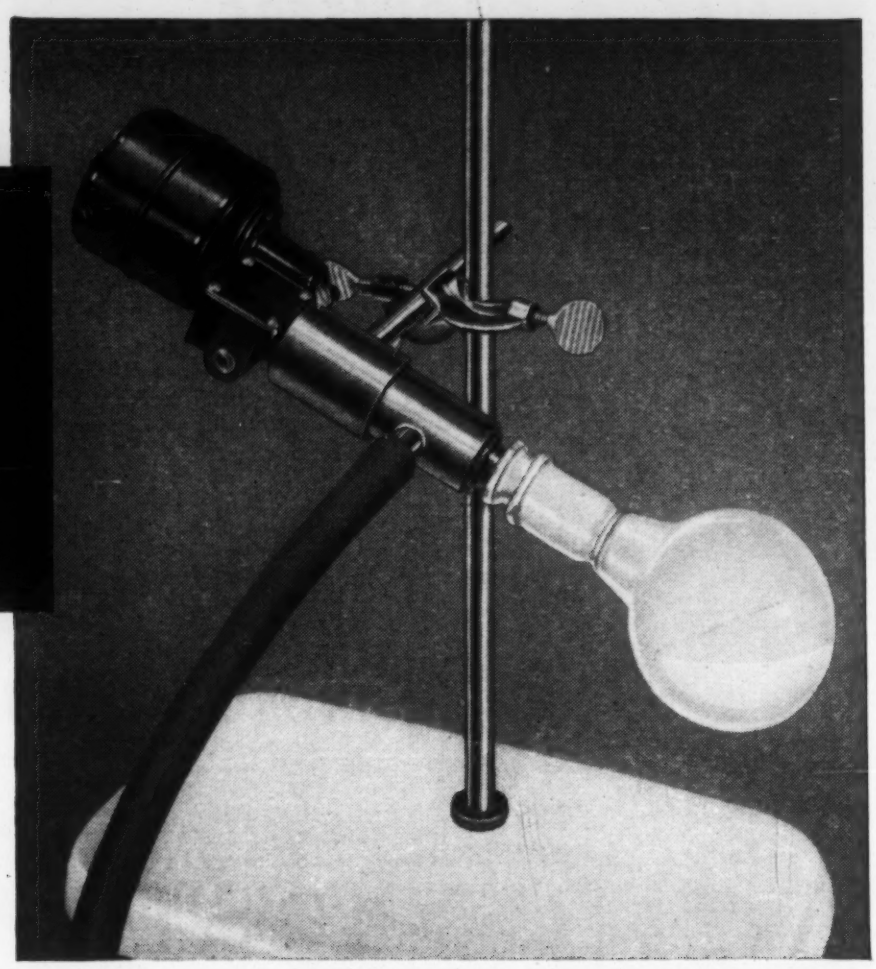
Rotoblast Tables & Table-Rooms

Special Blast Rooms & Cabinets

Pangborn Dust Control Equipment

Malleabrasive Shot & Grit

for rapid evaporation of solvents of low volatility



Use

THE RINCO ROTATING VACUUM-TYPE EVAPORATOR

(Patent Applied For)

● For speeding up routine evaporations. Handles volumes from 1 c.c. to 1000 c.c. Principle utilized — rotation of flask spreads out thin film over large area (diameter of flask) subjected to negative pressure. "Bumping" eliminated. Use of glass beads unnecessary. Rate of evaporation increased 4 to 5 times, depending on solvent used. Particularly advantageous with such solvents as water, dimethylformamide, etc. 30 ml. of water at 20° C will be evaporated in 30 minutes or less. Very useful with heat sensitive compounds and biological extracts since no temperature increases are necessary. Evaporator will, of course, operate satisfactorily at higher evaporation rates with increased temperature, when sample characteristics permit application of heat.

Evaporator consists essentially of a stainless steel shaft with a machined Standard Taper 19/38 joint at lower end. Shaft rotates on oilite bronze bearings within stainless steel housing having Standard Taper 12/30 take-off leading to vacuum pump or aspirator. Vacuum pump and trap are recommended for best results, but can be used with aspirator. Flask attached to Standard Taper joint at lower end of shaft rotates at approximately 60 r.p.m. by means of special motor. Standard Taper 19/38 joint accommodates smaller capacity flasks, i.e., 50 ml. H-63620 Reducing Adapters, Pyrex Brand Glass, permit use of larger flasks having Standard Taper 24/40, 29/42, etc. Entire apparatus can be easily disassembled for cleaning.

Can be adapted to single or multiple units.

Note: Support stand, clamp and glassware are accessories and may be ordered separately.

H-21655 — Rinco Rotating Vacuum-type evaporator complete with motor and cord for use on 115V 60C, A.C. . . . **$96.50**

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DIVISION OF THE HARSHAW CHEMICAL CO.
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For more information, turn to Reader Service Card, Circle No. 376

NATCO ENGINEERS

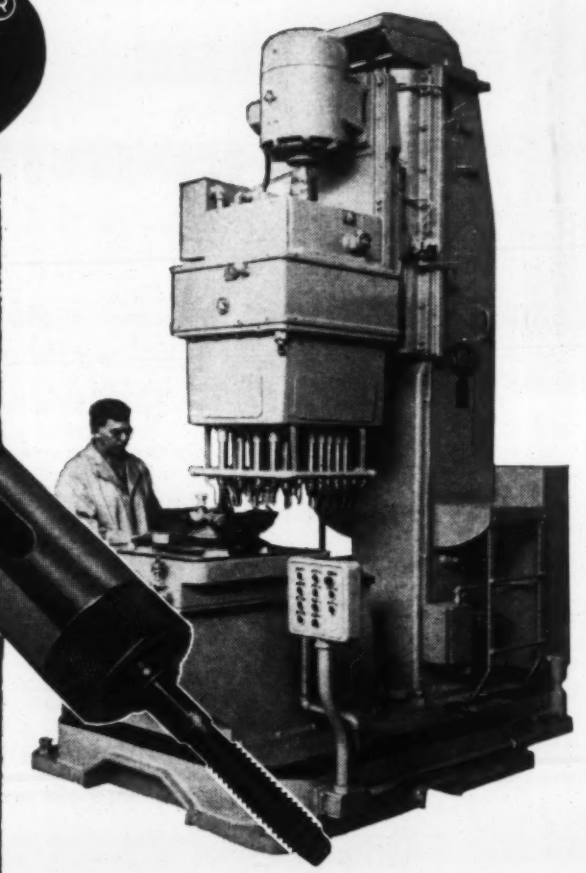
OVERCOME DISTORTION

DURING MACHINING

WITH

STRESSPROOF®

SEVERELY COLD-WORKED, FURNACE-TREATED STEEL BARS



The Lead Screw Tapper Spindles of this Natco Three-way Holetapper required machining operations hard to combine without serious distortion.

The front end of each spindle had to be machined as a taper socket for collet application. When the driving keyway and the tool knockout elongated-splined-holes were machined, distortion caused out-of-round taper holes which would not receive the collet correctly.

The rear end of each spindle had to be machined as a driving spline shaft which slides under load. Since the diameter of the spline is relatively small in proportion to the shaft length, any attempt to heat treat caused distortion hard to correct by straightening.

And at the center of each spindle, an accurate lead screw had to be machined by a thread grinding operation. It was found that the finish was much more easily obtained when STRESSPROOF was used.

STRESSPROOF eliminated both the problem of the out-of-round taper holes on the front of each spindle . . and the distortion of the driving-spline-shaft.

STRESSPROOF makes a better part at a lower cost.

National Automatic Tool Co. has for many years used STRESSPROOF in the manufacture of important operating parts for this Three-way Holetapper, as well as for other Natco high-speed machine tools.

WRITE TODAY FOR
Helpful Data
Bulletin No. 15
"Improve Quality
—Cut Costs"

AVAILABLE FROM LEADING STEEL DISTRIBUTORS COAST-TO-COAST

La Salle STEEL CO.

1418 150th Street, Hammond, Indiana

MANUFACTURERS OF AMERICA'S MOST COMPLETE LINE OF QUALITY COLD-FINISHED STEEL BARS

For more information, turn to Reader Service Card, Circle No. 402

How Harvey puts aluminum to work for you...

Here are a few of the many ways Harvey makes your product easier to manufacture, easier to sell

EXTRUSIONS... For decorative as well as basic parts, custom-designed aluminum extrusions replace riveted and welded assemblies... simultaneously increase strength and simplify fabrication.

STRUCTURALS... High strength, light weight, workability, corrosion resistance. Aluminum extrusions combine all four...are ideal as basic load-bearing members.

MACHINING STOCK... Harvey deep-drawn hex and round stock set a new mark in uniform grain structure—consistent from surface to core. This means fast, chatter-free cutting, long tool life, few rejects and true threads.

FORGING STOCK...If you make your own forgings in quantity, Harvey extruded forging stock can save many intermediate steps. Custom-designed extrusions whose cross sections approximate the forged blanks may be cut to length.

EXTRUDED PIPE AND TUBE...Seamless... uniform in structure, size and shape... clean and smooth inside and out... easily formed. Usable in applications ranging from portable irrigation systems to aircraft heat exchangers.

DRAWN TUBE... Combines strength and high finish... ideal for TV antennas, furniture, and similar products. Cold drawn for structural uniformity ... temper specially controlled for workability.

PRESS FORGINGS... Where parts must combine maximum strength with savings in weight, cost and manpower, Harvey aluminum forgings often completely solve a designer's problem.

IMPACT EXTRUSIONS... Thin-walled, tubular structures can be produced by this method and held to very close tolerances. Machining is practically eliminated, and scrap is greatly reduced.

AUTOMATIC SCREW MACHINE PRODUCTS ...The West's largest installation of multiple-spindle screw machines can reduce your manufacturing costs. Harvey carries your job through every step—from engineering through quality control.

Forty years of solving the special and difficult design problems of industry have developed the "practical imagination" that characterizes the entire Harvey approach. Our Field Engineers will gladly sit down with your own designers to determine in detail how Harvey's experience can put aluminum to work making *your* product easier to manufacture, easier to sell.

MAKING THE MOST OF ALUMINUM... FOR EVERYONE

HARVEY Aluminum

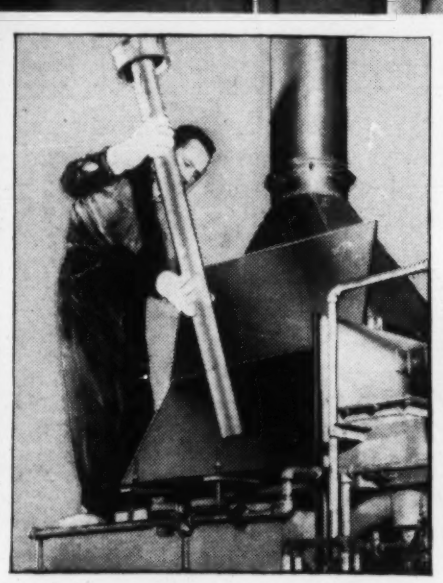
HARVEY ALUMINUM SALES, INC., TORRANCE, CALIFORNIA
BRANCH OFFICES IN PRINCIPAL CITIES

See Harvey's Catalog
in Sweets' File for Product Designers

RESEARCH . . . DEVELOPMENT . . . PRODUCTION . . . *Harvey does all three as a leading independent producer of aluminum extrusions in all alloys and all sizes, special extrusions, press forgings, hollow sections, structurals, rod and bar, forging stock, pipe, tubes, impact extrusions, aluminum screw machine products and related products. Also similar products in alloy steel and titanium on application.*

For more information, turn to Reader Service Card, Circle No. 360

MORE FURNACE VERSATILITY



Lindberg radiant tube is easy to change. Just turn off furnace, lift old tube out and put in new tube.

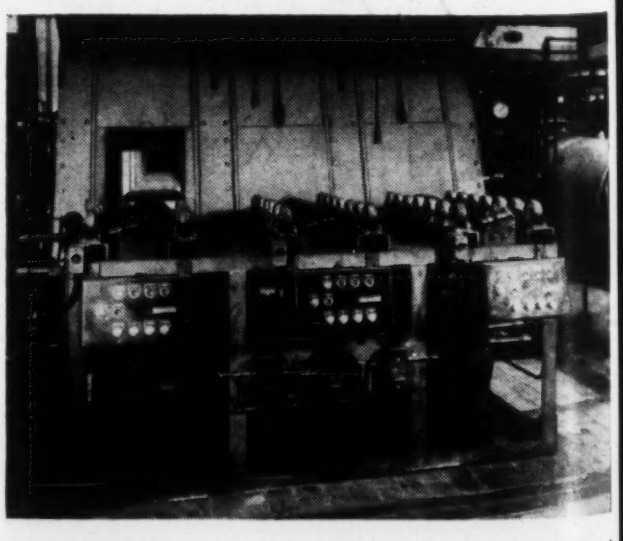
These are two of the three Lindberg gas-fired radiant tube carburizing and carbonitriding furnaces recently installed by an internationally known maker of farm machinery. With these furnaces 75% of parts are carbonitrided and 25% carburized. In addition, some bright annealing is done and the versatile Lindberg units can easily be converted for other heat treating applications.

Lindberg Vertical Radiant Tube Great Advance in Heat Treating Furnaces

When metal needs heat, Lindberg furnaces with the new Lindberg lightweight vertical radiant tube offer a better way to apply it. Industry the world over is finding that Lindberg furnaces with this new vertical tube provide a versatility no other type of furnace can give. Carbonitriding, carburizing, carbon restoration, bright hardening or annealing and normalizing are all possible with only minor adjustments.

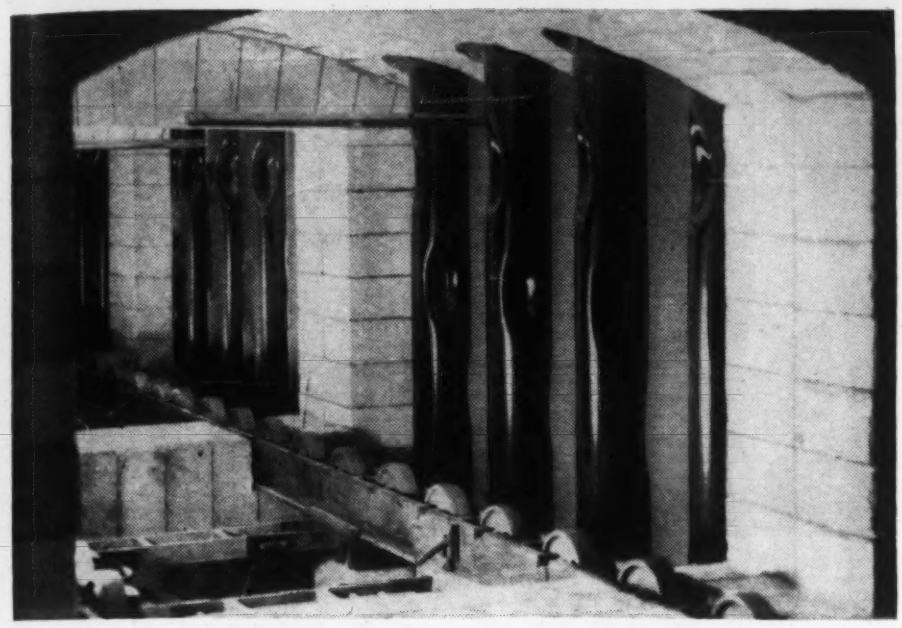
Here are some other exclusive advantages. Lindberg furnaces include a built-in pitless quench tank. Uniform case depth is assured because each charge automatically remains at heat the same length of time. A built-in purge chamber receives work loads for purging prior to heating.

Whatever type of furnace fits your production needs, from gigantic continuous pusher-type to the small manual batch-type furnace, Lindberg engineers can develop exactly the right equipment for you.



This three-row pusher Carburizer, with vertical radiant tubes between each row, was built for a large automobile manufacturer.

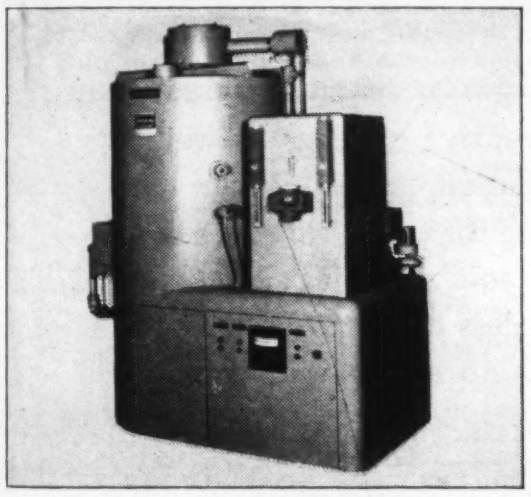
WITH LINDBERG RADIANT TUBES



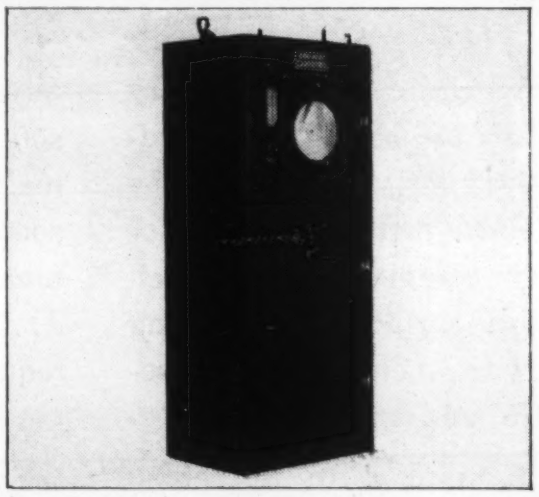
Here you can see the unique "dimpled" design of the new Lindberg vertical radiant tube. Installation is a Lindberg continuous pusher-type gas-fired carbonitriding furnace.

Revolutionary new development

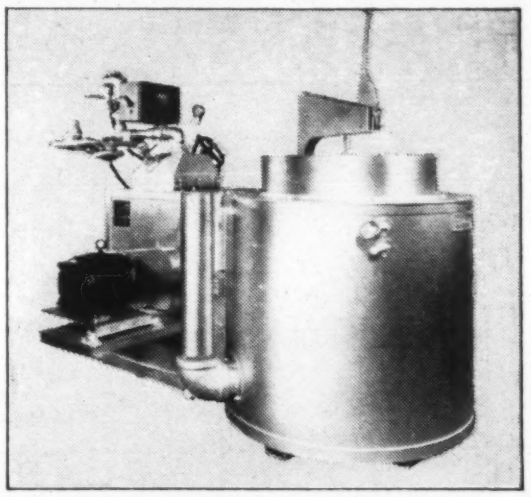
The development by Lindberg of the lightweight, easily-changeable vertical radiant tube (patent pending) is one of the most significant improvements ever made in industrial furnace design. It eliminates the bulk and bend problems of the old-fashioned horizontal tube and the uneven heat patterns inherent in earlier vertical tubes. The secret lies in the new Lindberg tube's "dimples". Here's how they work—in the radiant tube a central stream of mixed air-and-gas is surrounded by a cylindrical stream of air alone and combustion occurs in the area between these two streams. The "dimples" create eddies in the streams accelerating combustion and maintaining even temperatures along the entire length of the tube. If you aren't fully familiar with this revolutionary development ask us, or your nearest Lindberg Field Engineer about it.



This newly-designed Lindberg Hyen generator is used with Lindberg radiant tube furnaces to supply the most exacting atmospheres needed for any heat treatment.

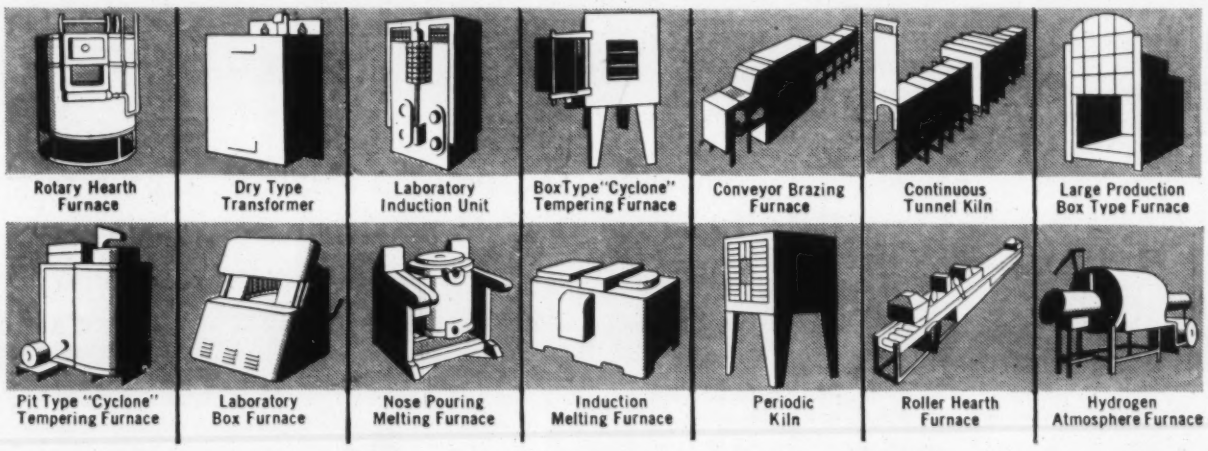


Here is the new Lindberg Carbotrol unit which automatically controls the carbon potential of furnace atmospheres provided by the Lindberg Hyen generator.



For the final step in heat treating, the famous Lindberg cyclone tempering furnace, for 20 years the standard of furnace performance. Pit or box type available.

Lindberg manufactures many kinds of equipment in the industrial heating and related fields. A few of these are symbolized here. If you are interested in any of these please write us for the specifics on them, or get in touch with your nearest Lindberg Field Engineer. (See your classified telephone book.)



LINDBERG ENGINEERING COMPANY

2451 West Hubbard Street, Chicago 12, Illinois

Los Angeles Plant: 11937 South Regentview Avenue, at Downey, California • **Associate Companies:** Lindberg Industrial Corporation, Chicago • EFCO-Lindberg, Ltd., Montreal, Canada • Lindberg Italiana, Milan, Italy • The Electric Furnace Company, Ltd., Weybridge, Surrey, England • Etablissements Jean Aubé, Paris, France • Lindberg Industrie Ofenbau, Gross Auheim, Germany

For more Information, turn to Reader Service Card, Circle No. 438

Here's an exciting new development in metallized ceramics!

NICOTE METALLIZED CERAMIC COATING

for use with both hard and soft solders!

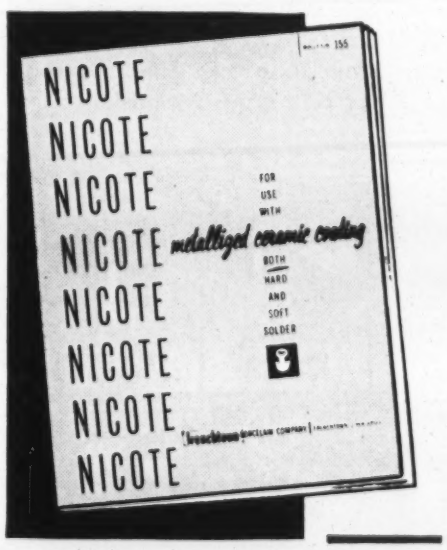
Here is Frenchtown's revolutionary answer to a problem that has baffled industry for years . . . a satisfactory *single* metallic coating for refractory ceramic bodies which provides a surface for applying solders with melting points between 275° and 1600°.

NICOTE, applied to refractory ceramic bodies by high temperature firing, in most applications requires no expensive preliminary processing such as buffing, electroplating, or tinning to form a strong, firmly-adhering bond with either *hard* or *soft* solders.

Whether the problem requires the fastening of a metal part or other metallized ceramic parts to its surface, NICOTE offers distinct advantages over ordinary silver soft receptive coatings as well as molybdenum and tungsten hard solder coatings. It will withstand molten soft soldering *indefinitely* . . . it's less costly to produce . . . requires no expensive processing.

NICOTE'S mechanical bond to the refractory ceramic body approximates ceramic strength, making it ideal for hermetic seals, high strength mechanical seals, and vacuum type applications.

Like to know more about the amazing possibilities of NICOTE Metallized Ceramic Coating for your product? Bulletin 155 contains complete engineering details. Write for a free copy today. There's no obligation, of course.



This idea starter is free for the asking . . . contains complete facts and details about NICOTE . . . Frenchtown's new **single metallic coating** for use with **both** hard and soft solders. Ask for Bulletin 155.

frenchtown PORCELAIN COMPANY

84 MUIRHEAD AVENUE | TRENTON 9, NEW JERSEY

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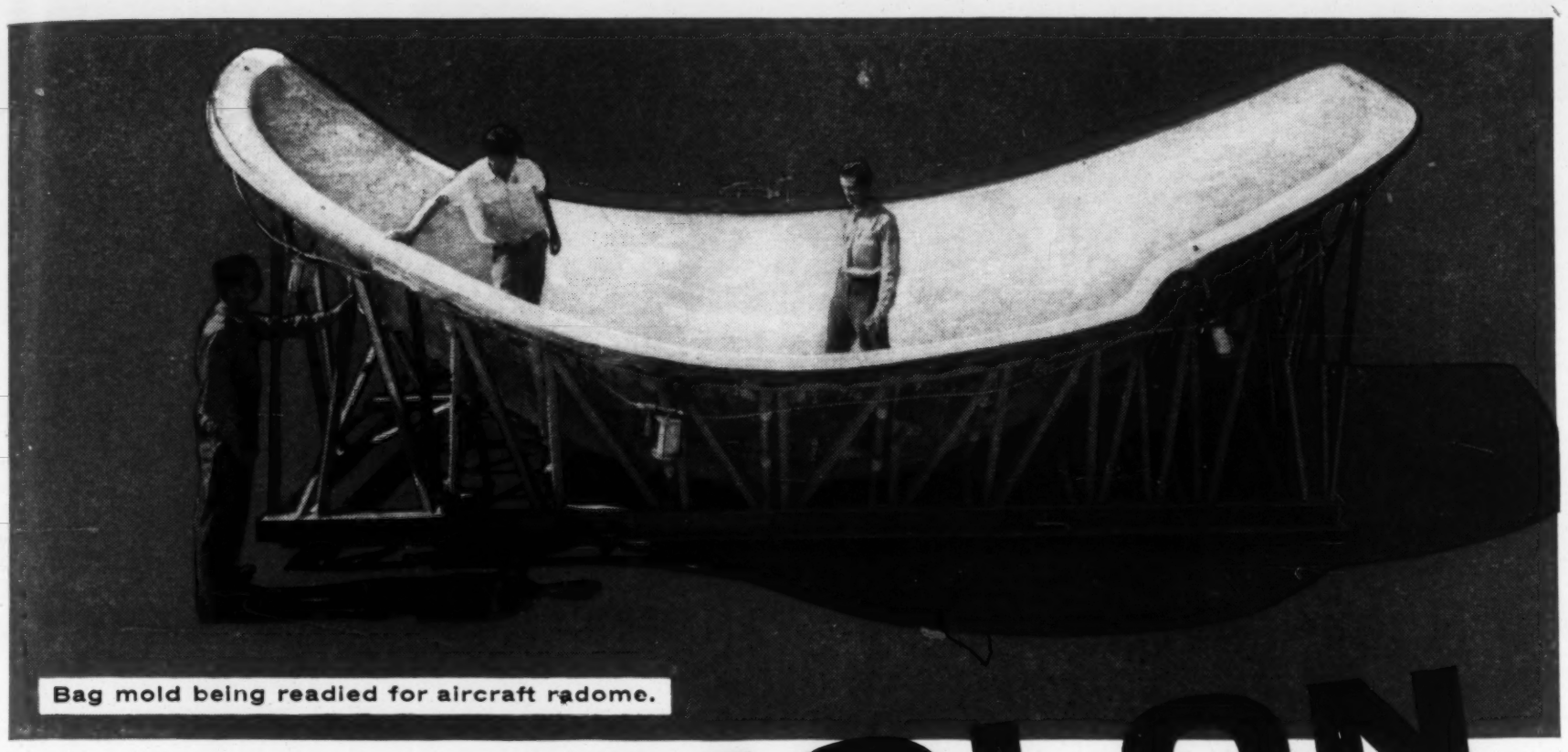
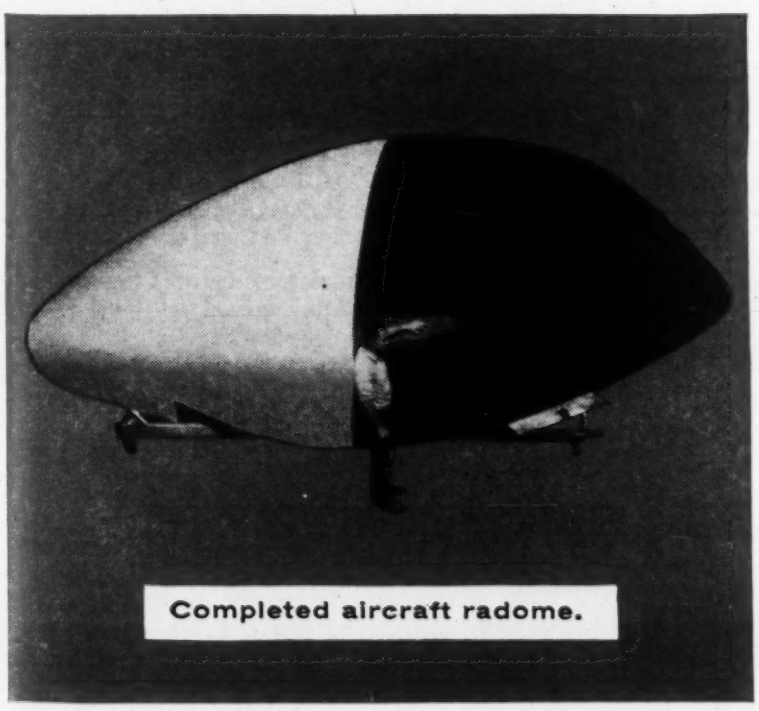
Small Part or Large... Produce Them Faster and at Lower Cost with



Bag mold being readied for aircraft radome.

REYNOLON

polyvinyl alcohol



Completed aircraft radome.

From the reinforced plastic pipe section to the aircraft radome above, bag molding with Reynolon Polyvinyl Alcohol Film offers definite advantages to design and production men in diversified industries. Plastic bag molds can be made faster than matched metal dies thus you can get into production quicker. Bag molds also are less costly than matched dies. And—the high elongation features of Reynolon Polyvinyl Alcohol Film as well as its non-inhibiting and clean separating qualities make it ideal for use in molding reinforced plastics. Design freedom is still another important "plus" for bag molding with Reynolon Polyvinyl Alcohol Film.

Highest quality, clear, strong Reynolon Polyvinyl Alcohol, Polyvinyl Chloride, Polyethylene and laminates of Polyethylene and Cellophane are all available in many standard specifications or can be economically produced for your specialized requirements. Our Technical Product Development Service is also available to you without obligation.

Photos courtesy of:
Zenith Aircraft
Division of Zenith Plastics Co
Gardena, Calif.

For complete information,
contact your nearest Reynolds Metals Company office or write

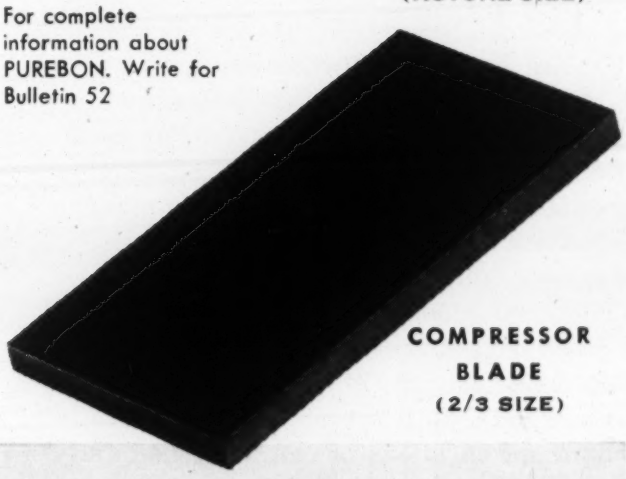
PLASTICS DIVISION,
REYNOLDS METALS COMPANY
3804 GEORGIA STREET • GARY, INDIANA

For more information, turn to Reader Service Card, Circle No. 328

. . . the solution to your Lubrication problem is here . . . PUREBON

Carbon-graphite especially designed for mechanical applications.

For complete information about PUREBON. Write for Bulletin 52



COMPRESSOR BLADE
(2/3 SIZE)

PURE CARBON CO., INC.

450 HALL AVENUE

ST. MARYS, PENNSYLVANIA

Purebon is the designer's solution to many knotty problems involving sliding or rotating parts where lubrication is difficult and sometimes impossible. Purebon parts are molded or machined exactly to our customers' specifications here in our own plant, under our close supervision and inspection. *Because of the diversified characteristics of Purebon, applications are limited only by the designer's imagination.* If you have a problem involving insufficient lubrication at critical points of friction, our design engineering department will be happy to work with you toward its swift and successful solution.

PUREBON'S PROPERTIES

1 ***MOLDED TO SIZE—FOR MANY APPLICATIONS***
Tolerances of approximately 1½% of dimension required for molding most shapes.

2 ***SELF-LUBRICATING—OR BY THE MATERIAL HANDLED***
Varies with grade of Purebon.

3 ***STRONG AND TOUGH***
Transverse strength varies from 4,000 to 13,000 lb./sq. in. according to grade.

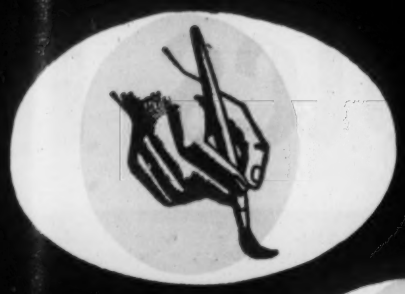
4 ***READILY MACHINABLE***
Tolerances as close as .0005 can be maintained where required.

5 ***CHEMICALLY INERT—NON-TOXIC***
Resistant to attack by chemicals of all kinds, used in food handling and processing equipment.

6 ***HIGH TEMPERATURE APPLICATION***
Most Purebon grades will operate efficiently in temperatures up to 700°F in air or much higher in neutral or reducing atmosphere.

Leaders for over 40 YEARS in PURE CARBON PRODUCTS

For more information, turn to Reader Service Card, Circle No. 334



use 'dag' dry films for trouble-free lubrication

Where the lubrication of inaccessible mechanisms will surely be neglected . . . when you cannot be certain of regular maintenance . . . 'dag' dispersions can be used to give your product *lifetime dry-film lubrication.*

'dag' Colloidal Graphite is high-purity electric-furnace graphite, treated to produce micron-size particles and dispersed in many paste and liquid carriers. As a lubricant it is chemically inert; it is insoluble in acids, alkalies, or solvents; it is electrically conductive. 'dag' Colloidal Graphite forms durable, tenacious, *dry lubricating films* which are not affected by temperatures up to 750°F. and which are equally effective under sub-zero conditions.

The popular new solid lubricant, molybdenum disulfide, is also available in various dispersions for specialized lubricating problems. 'dag' dispersions are easily applied by spraying, brushing, or dipping.

You'll find a surprising number of ways to use 'dag' dispersions described in our free booklets: High-Temperature Lubrication; Surface Coatings and Impregnation; and Dry-Film Lubrication. Write for Bulletins No. 423-T5, No. 435-T5, and No. 438-T5.

We are equipped to do custom dispersing of solids in a wide variety of carriers.

You can design for lifelong lubrication with 'dag' dispersions

ACHESON COLLOIDS COMPANY

PORT HURON, MICHIGAN

...also ACHESON COLLOIDS LIMITED, LONDON, ENGLAND

For more information, turn to Reader Service Card, Circle No. 337

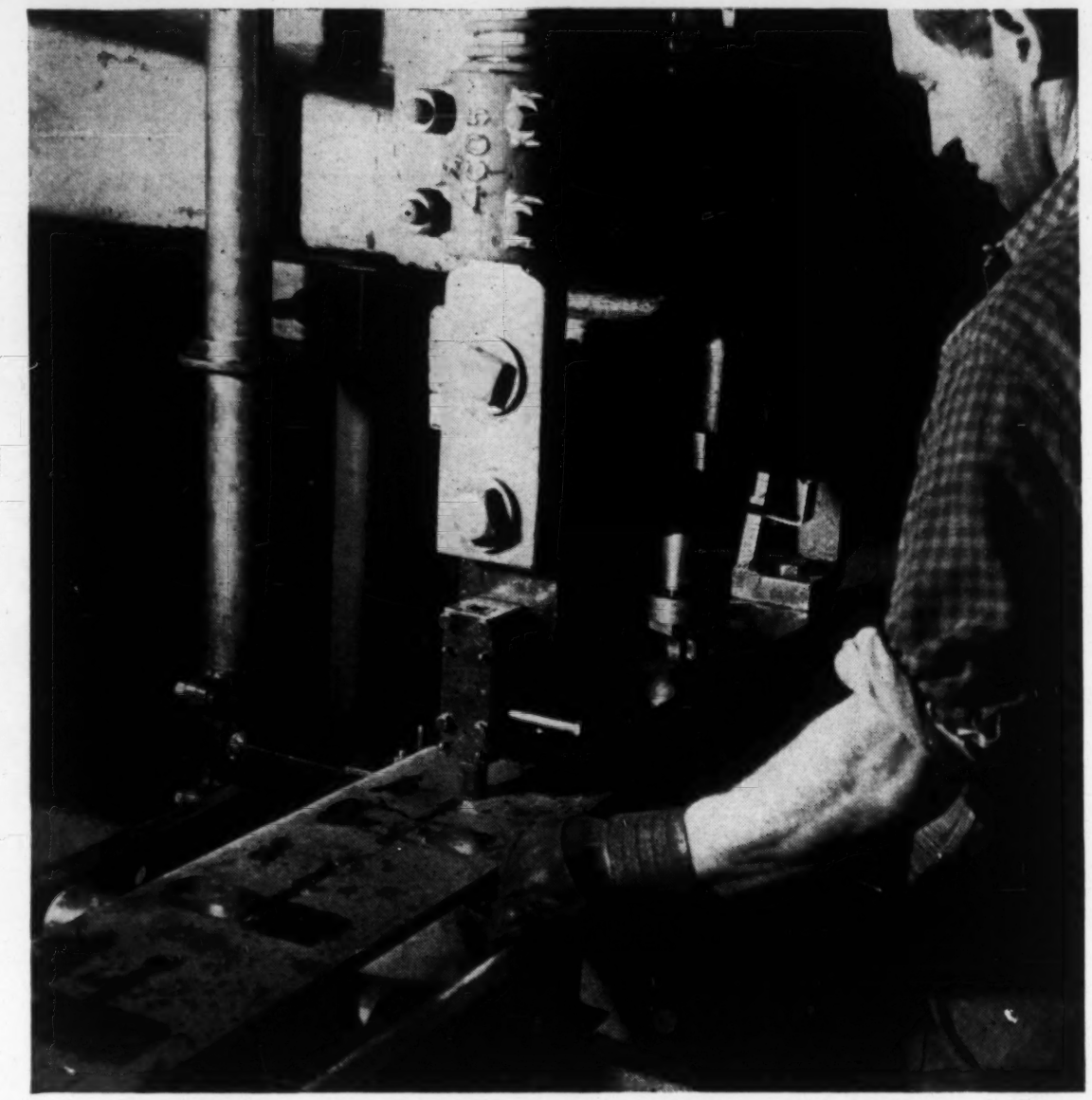
Tool Steel Topics

BETHLEHEM STEEL

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributors: Bethlehem Steel Export Corporation



This Bearcat punch (shown above man's wrist) punches 15 square holes in each ½-in. steel plate, used as cutting edge of snow plows. Average life of punch is 5500 holes, with only three light redressings.

See What They Gained by Switching to Bearcat!

One of the operations performed in the shops of Frink Sno-Plows, Inc., Clayton, N. Y., is punching 15 holes, 11/16 in. square, in a carbon-steel plate. The plate, ½-in. thick, is used as the cutting edge of highway snow plows. With grades of steel previously used in this punching operation, the service life of each punch varied considerably—anywhere from 300 to 1500 holes.

We felt confident that Bearcat tool steel could do better, and they agreed to give it a trial.

So Bearcat was put to work, with the punch hardened to Rockwell C56-57. Production went up immediately. Now the life of each punch is approximately 5500 holes, with only light redressing of the corners required every 1500 holes or so.

Bearcat is a tough, general-purpose air-hardening tool steel. When used in punches, its chief advantages are exceptional resistance to shock, and superior resistance to wear. Besides, Bearcat's air-hardening characteristic minimizes quenching hazards, and provides good resistance to distortion in heat-treatment.

In addition to punches, there are many other applications where Bearcat can be used to advantage: rivet sets, for example, and chisels, gripper dies, hot headers, master hobs and die-casting die inserts, to name only a few.

Why not learn for yourself how good a tool steel Bearcat really is! You can order it right now through your Bethlehem tool steel distributor. It can also be obtained from our well-stocked mill depot.

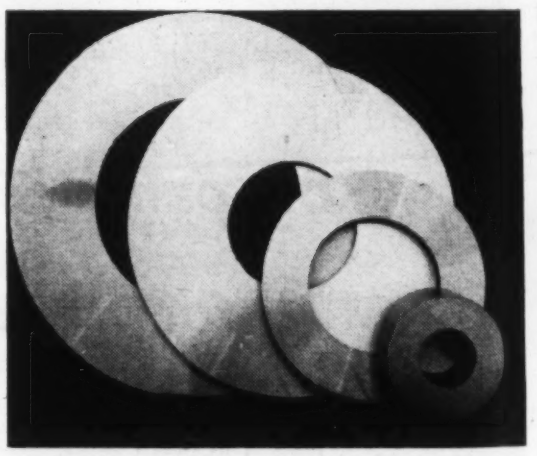
BETHLEHEM TOOL STEEL ENGINEER SAYS:

Switching Grades Won't Cure Tool Troubles

Granted that quality is of primary importance in tool steel. But there are four other factors which are also essential to the satisfactory performance of tools: (1) good design, (2) correct heat-treatment, (3) proper grinding, and (4) proper application and mechanical use of the tool.

Ordinarily a manufacturer's responsibility lies only in quality. Yet if results are unsatisfactory the user often concludes that "the steel is no good," whereas any of the other factors mentioned may be the real culprit. That is why it is so important to investigate all five of these factors. For they are like links in a chain: unless they are in reasonably good balance, trouble can be expected. When this happens, the tool and its work must be investigated thoroughly before a remedy can be suggested.

In the majority of cases, switching grades is not the answer in attempts to cure trouble with tools, for the difficulty usually lies elsewhere. Before switching grades, the user should first have a clear-cut reason for doing so, and definite objective. Otherwise, the original trouble may be intensified, rather than removed.



BETHLEHEM HOLLOW-BAR SAVES TIME IN RING-TYPE APPLICATIONS

If you work with ring dies, draw rings, or hardened bushings, you can save time by using Bethlehem Hollow-Bar Tool Steel, either in BTR (oil-hardening) or Lehigh H (high-carbon, high-chrome). Hollow-Bar is made by high-speed trepanning. By this process, hammer-forged or hot-rolled bars are cored out, and are then rough-turned on the outside. With Hollow-Bar, there's no need to wait for forged rings or discs.

For more information, turn to Reader Service Card, Circle No. 437

I Could Kick Myself!

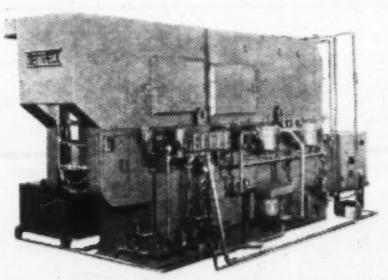
"Yes sir. When I think of the money we could have been saving the past few years, I could kick myself. One day the Detrex man pointed out that metal cleaning and surface preparation accounted for ¼ to ⅓ of all operations performed in the average metalworking plant. That started the gears in motion, and after checking, I was quite surprised to find that over 25% of our operations were of that type. Sure, I knew that we had some metal cleaning operations here and there in our plant, but I never realized the extent of the overall operation until we actually made a survey.

"As a result, savings that appeared insignificant from an individual basis, became very important from the overall standpoint. It certainly changed my thinking regarding chemicals and equipment for metal cleaning and surface preparation.

"Take for instance degreasing equipment. I asked the Detrex man to look over our metal cleaning operations to see what could be done to improve our operation and *cut costs*. The result—we now are using the Detrex Soniclean Process *. We always had difficulty getting certain parts really clean because of their shape and contour. Now we clean them by using sound waves. No matter how inaccessible certain spots are, the Soniclean process cleans them *thoroughly*.

"I suppose I'm not the only man that wasn't too impressed with the importance of metal cleaning from the overall operational standpoint. Perhaps you're like me. Maybe you've never taken a good look at the importance of these operations in your plant. If so, you'll be surprised at the total number of operations involved and the extent to which savings can be realized.

"It isn't going to cost you a thing to let the Detrex man make the same survey in your plant. The results will speak for themselves. You have everything to gain and nothing to lose. Give him a crack at it today."



*ULTRASONIC SCRUB BRUSH

Detrex Soniclean Process uses sound waves to blast dirt from metal and leave parts cleaner than ever before. Electrically created sound waves are beamed through a solvent bath at a frequency of hundreds of thousands of cycles per second. The intense turbulence blasts the solvent into every pore and crevice, leaving the metal instantly and completely clean.

Service with a Saving!

DETREX CORP.

Dept. 302 • Box 501, Detroit 32, Mich.

DEGREASERS • DEGREASING SOLVENTS • WASHERS
ALKALI & EMULSION CLEANERS • DRYCLEANING
EQUIPMENT • PHOSPHATE COATING PROCESSES

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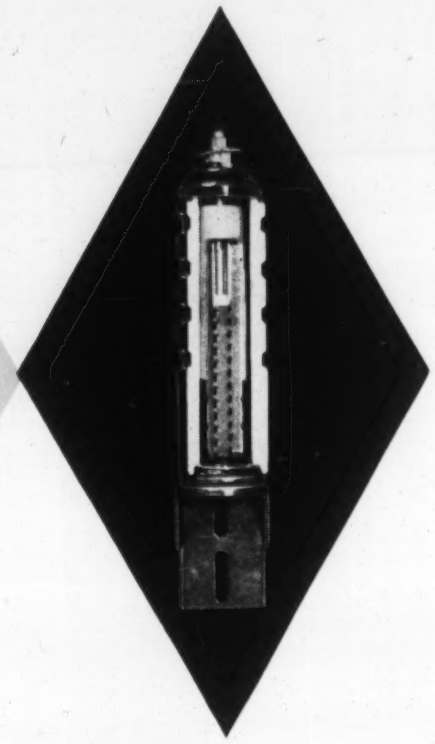
lightning made a direct hit



Here's where the action took place! This shows the transformer's "safety valve" of National Vulcanized Fibre. Sleeve and threaded spiral insert —both supplied in the form of precision-fabricated parts—are constructed of this tough, arc-resistant cellulose material. Spiral construction of arc chute insert distorts, elongates and tames electric arc so that no damage is done. At the same time, heat causes the fibre to release an arc-quenching gas. Result: perfect safety for valuable equipment protected by National Vulcanized Fibre.

but couldn't knock out the transformer

how a National Vulcanized Fibre part costing only a few dollars saved a transformer worth thousands, and was ready to go to work again

Lightning blasted this line pole like an exploding bomb—but left the Westinghouse distribution transformer undamaged. There wasn't even a minute's interruption in the flow of current.

Reason: National Vulcanized Fibre. A barrier of this tough, arc-resistant material in the transformer's lightning arrestor absorbed the tremendous surge of voltage—tamed and quenched the arc—dissipated intense heat and dangerous gases harmlessly.

It cost the power company only a few dollars to safeguard equipment worth thousands. And there's *your* clue to safety *and* savings in power switching equipment and thousands of other electric applications. Fine electrical properties and mechanical toughness—excellent machinability—unusual formability—light weight—great resistance to heat, shock and abrasion—National Vulcanized Fibre has them all. And you get them at low cost!

Somewhere in your products or your processing, there's a use for versatile, economical National Vulcanized Fibre. Let's explore the possibilities together. Technical and descriptive literature and application assistance for the asking.

Photo courtesy of Westinghouse Electric Corp.

Send for your free 16-page Technical Bulletin today. Address Dept. D-7.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

In Canada: **National Fibre Company of Canada, Ltd.** • Toronto 3, Ont.

Also Manufacturers of Peerless Insulation, Materials Handling Receptacles, Vul-Cot Wastebaskets and Textile Bobbins.

For more information, turn to Reader Service Card, Circle No. 452

Your latest reference to better production

NEW J & L BOOKLET ON

EXTRUDED SECTIONS

WITH J&L EXTRUDED SECTIONS YOU CAN:

1. **ELIMINATE**
   time and costs in machining operations.
2. **ELIMINATE**
   time and costs in finishing operations.
3. **REDUCE**
   scrap losses practically to the zero point.
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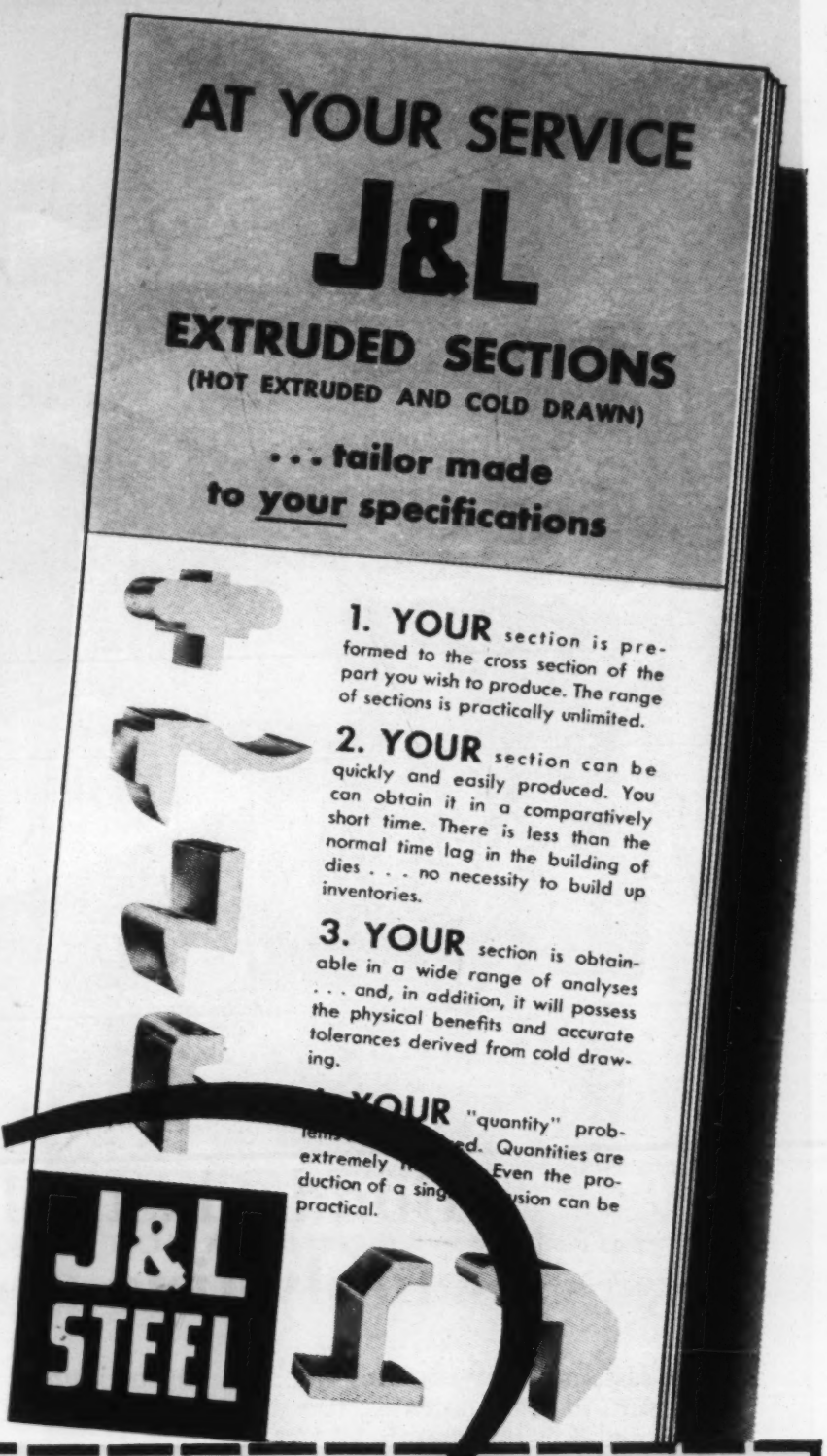
   the cost of castings and forgings of intricate sections requiring considerable machining.

J&L Extruded Sections are Custom-Made *for you*. They can be preformed to the predominating cross section of the part *you* wish to produce. And the range of sections is almost limitless. These sections possess the physical benefits and accurate tolerances derived from cold drawing. And you can obtain them in a wide range of analyses.

Use this handy coupon. This new booklet contains detailed information about the money and time saving advantages realized with the use of J&L Extruded Sections.

Jones & Laughlin
STEEL CORPORATION — *Pittsburgh*



J&L STEEL

Jones & Laughlin Steel Corporation
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Pittsburgh 30, Pa.

Please send me your new Booklet on EXTRUDED SECTIONS.

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Company_____

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For more information, turn to Reader Service Card, Circle No. 478

Bond plastic laminates with assembly-line speed and economy

For fast, positive assembly-line bonding of high-pressure plastic laminates, use the adhesive that's designed for this tough job—Armstrong D-253.

D-253 has unusually high dead load strength, bonds plastic laminate firmly, permanently—and instantly. The tough, flexible D-253 bond also has high shear strength, excellent resistance to moisture, and good resistance to heat.

Armstrong D-253 is ideally suited to assembly-line use. Applied by spray gun to core and skin sheets, it dries in less than a minute under infra-red heat. After assembly, one run through a pinch roll completes the lamination. D-253's high immediate strength makes it possible to fabricate panels—or ship them—minutes after bonding.

Write today for your copy of our 1955 Adhesives Manual, free to industrial users. Armstrong Cork Company, 8007 Dunbar Street, Lancaster, Pa. In Canada, Armstrong Cork Canada Ltd., 6911 Decarie Boulevard, Montreal, Quebec.

Armstrong

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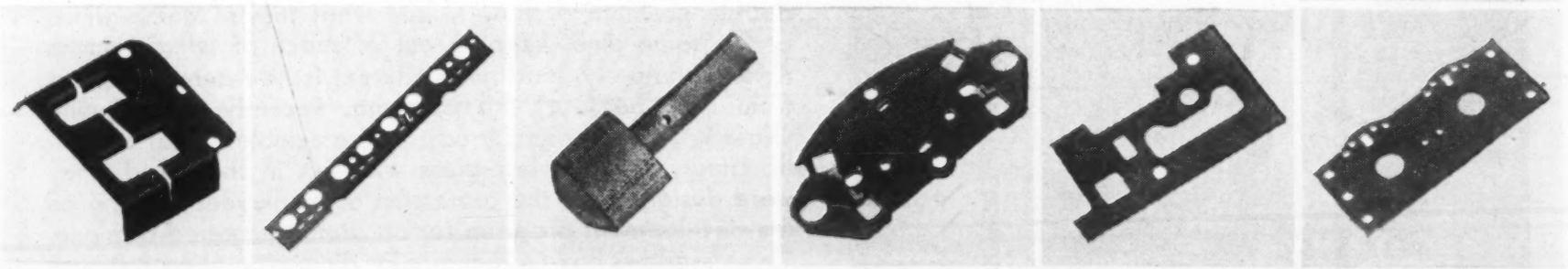
Spaulding

PRODUCTS FOR INDUSTRY

TAKE ADVANTAGE OF SPAULDING'S "START TO FINISH" SERVICE ON PARTS PRODUCTION

Spaulding basic materials offer a wide variety of electrical, chemical and physical property combinations which make them ideal for solving parts design problems throughout all industry. To utilize these materials to best advantage, call on Spaulding's "start to finish" service. This includes consultation at the design stage, manufacture of the basic materials and fabrication of the finished parts.

We can often suggest practical modifications of design or grade of material that will reduce your costs. By having us fabricate your parts, you eliminate the need to carry stocks of basic materials or to invest in the special equipment often required for maximum efficiency. Since all operations are carried on in our own plant, you can be sure your order will be handled expertly, expeditiously and without shift of supervision or responsibility.



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VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.

ARMITE: Thin Insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.

SPAULDITE: (Laminated Phenolic Plastic) in sheets, rods, tubes and fabricated parts.

SPAULDO: Motor Insulation in sheets, rolls, coils, slot cells and other fabricated parts.

SPAULDING FIBRE BOARD: In sheets and fabricated parts.

SPAULDING T BOARD: A superior Transformer Board, in sheets and fabricated parts.

MATERIALS HANDLING EQUIPMENT: Factory trucks, Boxes, Barrels, Trays, etc.

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Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation.

SPAULDING BRANCH SALES OFFICES

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TORONTO 18, ONT., CANADA A. A. Andersen & Co.

For more information, turn to Reader Service Card, Circle No. 314

LEAD-the Invisible Barrier

The heaviest picture window of them all. Almost as dense as steel, this heavily leaded window will permit observation while providing radiation shielding at the A.E.C.'s engine test facility at Idaho Falls, Idaho. *Corning Glass Works*

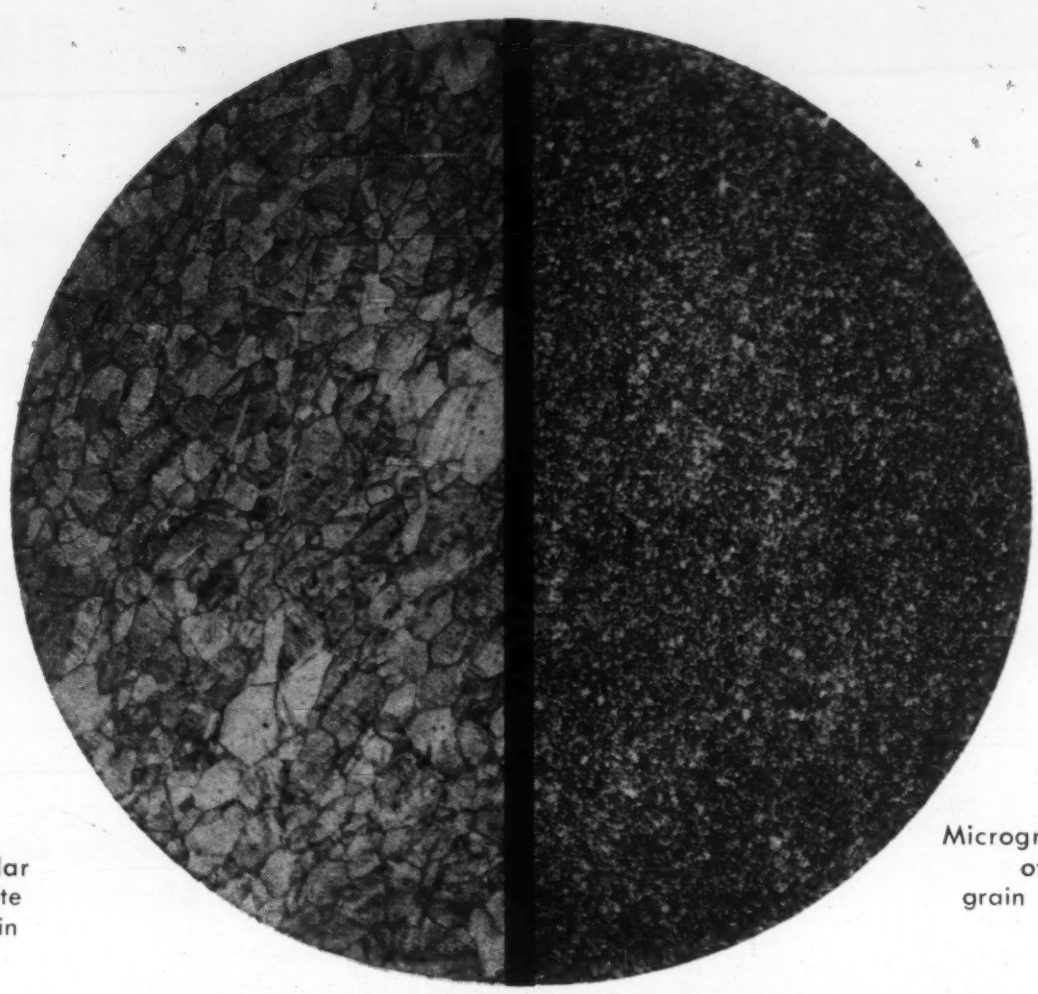
The harnessing of atomic energy has brought with it the problem of controlling the dangerous gamma rays emitted during atomic disintegration. Since the ray-stopping power of the shielding material is a function of its density, metallic lead — the densest of all commonly available metals — is the most widely used material of construction in radiation-barriers.

This property of lead is also responsible for the increasing use of litharge, a lead compound which, through chemical reaction, becomes a clear, transparent lead silicate — the principal component in a recently developed high-density glass. In this application lead not only acts as a barrier for protection, but also as a medium for observation. Those who delve into molecular manifestations often face the double problem of how to *see* what they're doing while, at the same time, keeping out of reach of lethal gamma rays. Fortunately, lead glass can extricate research workers from both horns of this dilemma. Recently, the Corning Glass Works successfully cast and assembled what are undoubtedly the heaviest glass windows in the world. They were designed for the protection of employees working on the development program for an atomic-powered airplane. These windows have a rectangular dimension of 6 x 8 ft.; are 6 ft. thick and weigh as much as 12 tons. The window glass has a density of 6.2 and is about the densest glass ever made — almost as dense as steel — with this important difference: It enables the operator in the control room to see through what might be called transparent lead, since some of this glass analyzes up to 75% of metallic lead by weight. Using remarkable remote-control manipulators, scientists are able to perform their experiments by looking through these high-density leaded glass windows without fear of radiation injury. Thus lead — one of the oldest metals known to man — is a major factor in the development of man's newest scientific discovery, Nuclear Energy.

ST. JOSEPH LEAD COMPANY
250 PARK AVENUE, NEW YORK 17, NEW YORK
THE LARGEST PRODUCER OF LEAD
IN THE UNITED STATES

Get longer life in formed parts AT NO EXTRA COST

USE THE NEW FINE GRAIN PHOSPHOR BRONZE WITH 30% GREATER ENDURANCE LIMIT



Micrograph (75x magnification) of regular phosphor bronze. Note relatively coarse grain structure.

Micrograph (75x magnification) of Duraflex. Its fine grain structure is the secret of its superiority.

DURAFLEX*

BY ANACONDA

DURAFLEX is a new, fine-grain phosphor bronze developed and sold only by Anaconda. Comparative fatigue tests show that the endurance limit of DURAFLEX is approximately 30% higher than for regular phosphor bronzes. In surface appearance, surface smoothness and hardness, it is superior to other phosphor bronzes. It is unsurpassed in corrosion resistance by any other phosphor bronze. Further, its formability is increased with no sacrifice in yield strength. DURAFLEX is a *premium* phosphor bronze in every way except cost; there's *no increase in price.*

If you're now using a hard-temper phosphor bronze, chances are that you can do the same forming in extra-hard temper DURAFLEX.

If you're looking for longer life in the parts you form, we'll be glad to send you a free sample of DURAFLEX. Try it, test it, and you will agree that it is superior.

5581

*Trade Mark

SEE FOR YOURSELF—

AN

ANACONDA®

PRODUCT

MADE BY THE AMERICAN BRASS COMPANY

FREE SAMPLE

The American Brass Company, Waterbury 20, Conn.

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Yes, we'd like to try DURAFLEX. Please send us a free sample of

sheet in_____**temper,**_____**thick,**

wire in_____**temper,**_____**diameter.**

☐ **We'd like to talk to one of your representatives about DURAFLEX.**

NAME . . . . . .

COMPANY . . . . . .

STREET . . . . . .

CITY . . . . . **STATE** . . . . . .

SHEET . . . up to 0.062" thick
WIRE . . . up to 3/16" diameter (approx.)

For more information, turn to Reader Service Card, Circle No. 419

CLEANING SPECIALISTS

give you a "brighter" outlook on life.

It's amazing how pleasant the view can be after one of these steel-nerved, sure-footed, alert Cleaning Specialists have done their job.

Northwest's Metal Cleaning Specialists are "alert" to your problems when it comes to giving your products a "brighter" outlook. Day in—day out, Northwest carries on the constant search for better, lower cost, analytically-correct cleaners to give you dependable, good looking, permanent finishes.

From Northwest's years of experience in developing job-adjusted cleaners for your specific needs have come such processes as the LO-HI pH—for cleaning prior to plating, painting or vitreous enameling; ALKALUME—for preparing aluminum for finishing and spot welding; INTERLOX—for phosphate coating; SPRA-LUBE—to control over-spray of "today's" paints in water wash paint booths; PAINT STRIPPERS—specific to your needs; SUPER-DRAW & FLUID FILM—for drawing metals.

Northwest's production-tested chemicals and "Right-the-first-time" recommendations will save you money. Northwest Service is as close as your phone.

Remember —YOUR COST PER FINISHED ARTICLE IS THE TRUE COST OF YOUR CLEANER

NORTHWEST CHEMICAL CO.

9310 ROSELAWN DETROIT 4, MICH.

pioneers in pH cleaning control *serving you since '32*

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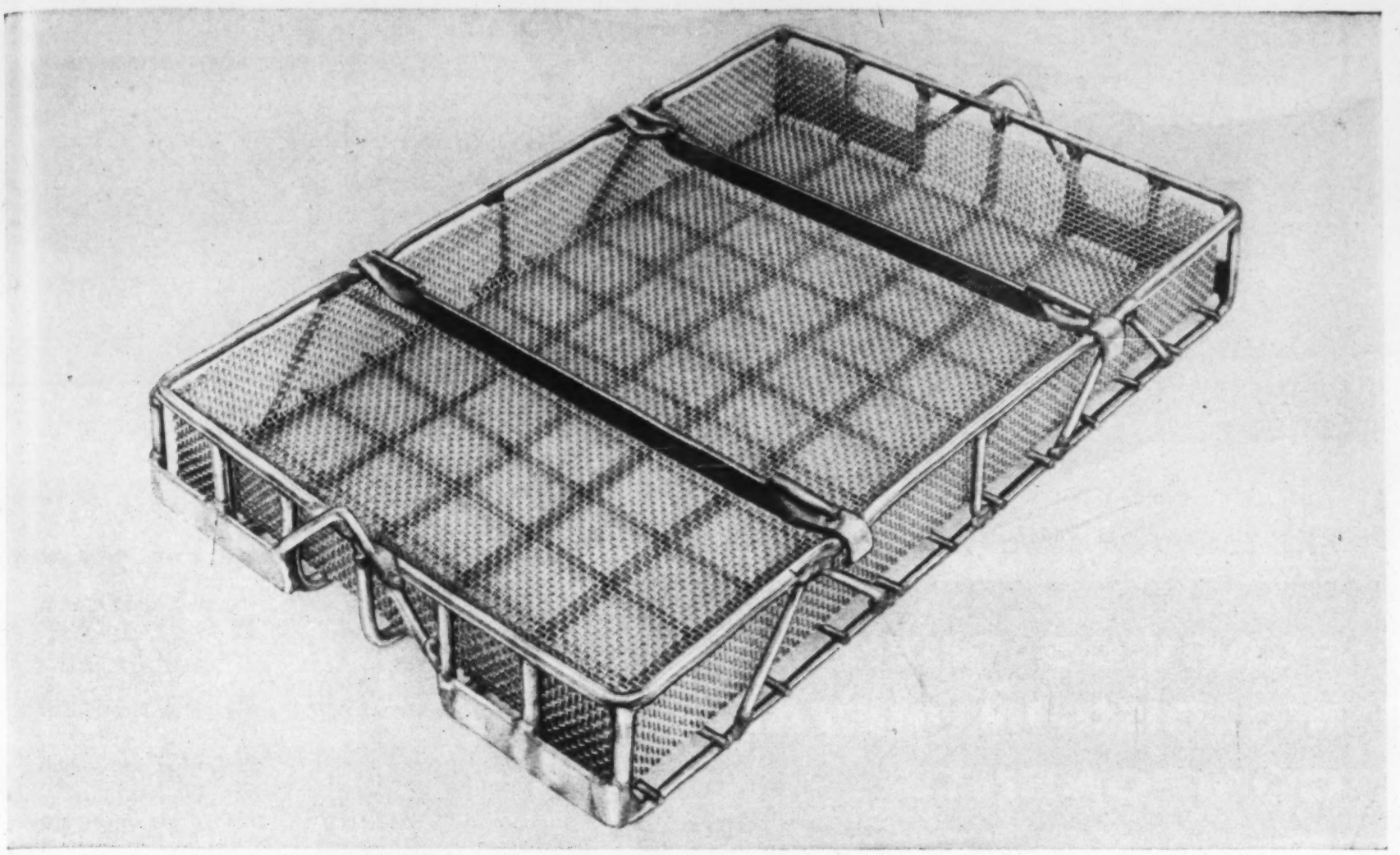


Easy-to-handle, long-life Inconel carbo-nitriding basket developed for use in Ipsen batch carbo-nitriding furnaces by Rolock Incorporated, Fairfield, Conn. Cross-braces are removable — used only when baskets are double-decked in furnace.

Through Inconel... ROLOCK designs lighter, more durable carbo-nitriding baskets for IPSEN furnaces

Today, a lot is being done with Inconel® to develop lighter, stronger and more durable heat treating equipment and fixtures.

Here's one promising example, so new that field tests are still incomplete... A Rolock carbo-nitriding basket for Ipsen batch type furnaces. The design takes advantage of *three* Inconel properties.

Inconel retains good strength up to 2100°F. Rolock exploits this property in two ways. Using minimum diameter Inconel rod, welded, they obtain a light but rugged frame good for medium and large parts. Using an open-mesh, woven Inconel screen, they construct a replaceable inner liner to contain small parts. The result: maximum pay load, minimum weight. Strength enough for stacking, as well.

Inconel resists carbo-nitriding and high temperature corrosion. This is an Inconel property that Rolock passes along directly to its customers. Because strong, tough Inconel has longer "hot" life, they can design for maximum practical life with minimum practical weight.

Inconel withstands severe thermal stressing without cracking or spalling. High "hot" strength, low coefficient of expansion, and the formation of a tight protective oxide, give Inconel high value in properly designed fixtures and equipment. In complex structures, these Inconel properties prevent premature distortion or cracking even after severe thermal shock. In this instance, Inconel helped Rolock build a lighter, more durable carbo-nitriding basket.

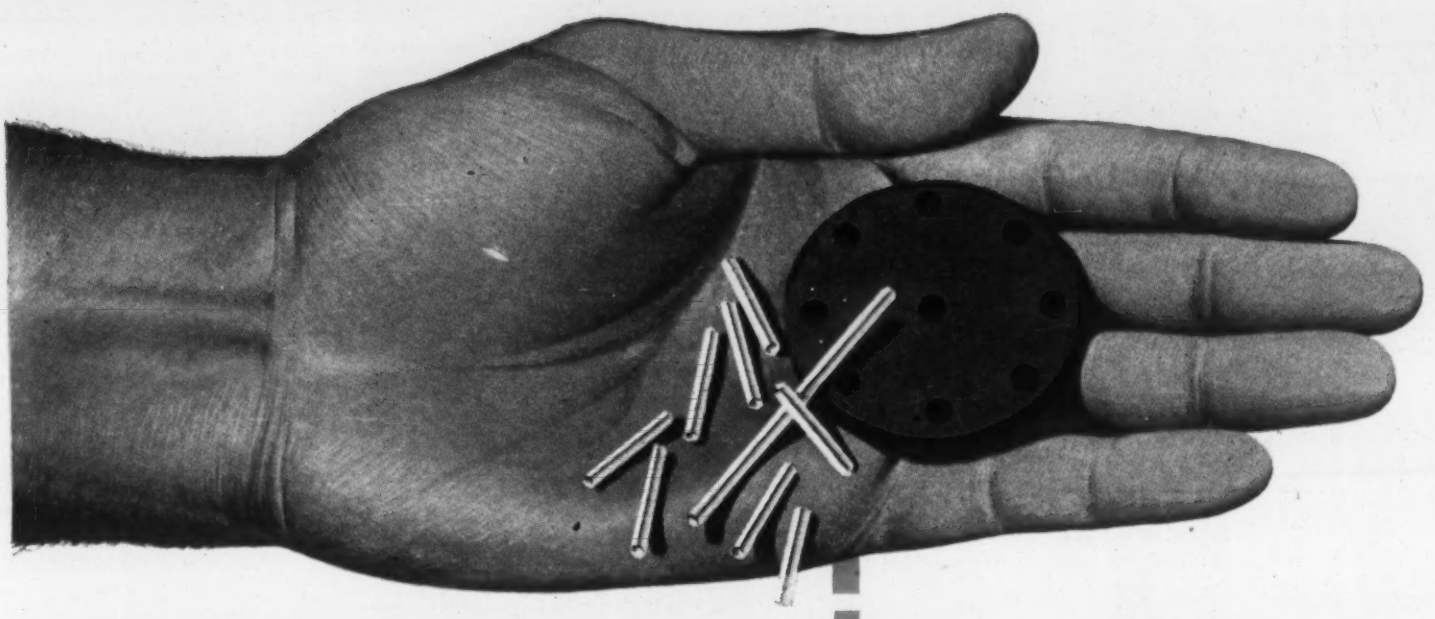
"Keeping costs down when temperatures go up"... is an Inco booklet that's packed with ideas for applying Inconel's properties and devising improved heat treating equipment. Write for a copy, today.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

Inconel... *for long life at high temperatures*

INCO TRADE MARK **Nickel Alloys**

For more information, turn to Reader Service Card, Circle No. 321



PAY LESS FOR MORE RUGGED

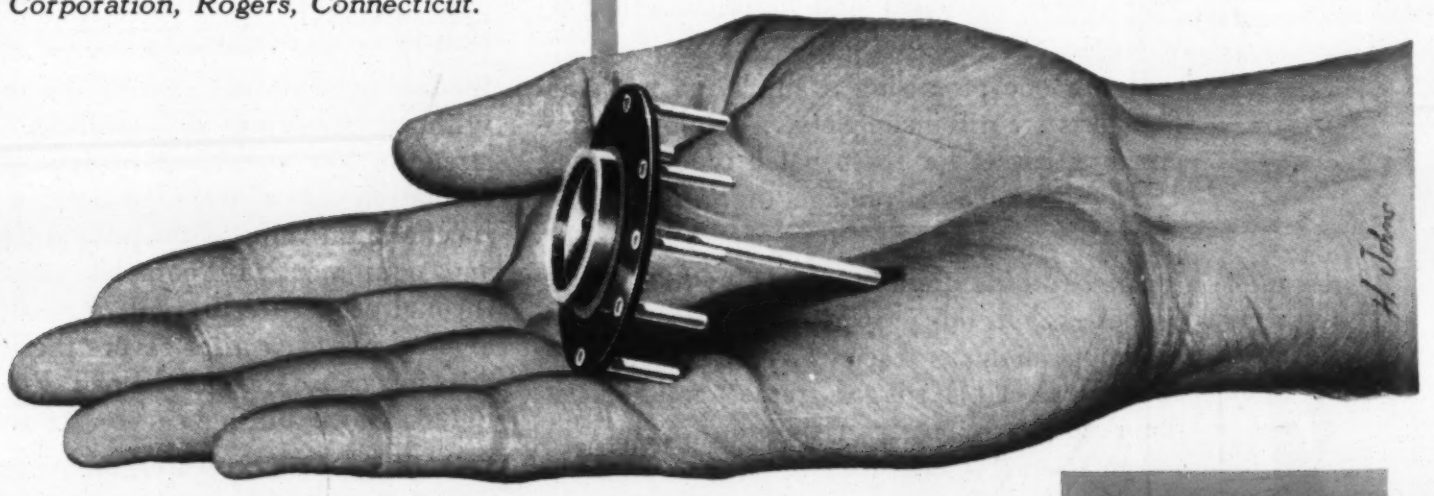
PLASTICS WITH MOLDED-IN METAL COMPONENTS

USE ROGERS PHENOLIC SHEET MOLDING MATERIALS

Three series of Rogers phenolic *sheet* molding materials are available: RM 9275, a cellulose-filled grade with an impact strength of 1.8; RM 4000 grades, glass-cellulose reinforced, with impact strengths ranging from 4.0 to 7.0; and RM 2035, an electrical grade, designed when properly molded to meet electrical standards equivalent to NEMA XXXP laminate. *Please write for data sheets to Dept. M, Rogers Corporation, Rogers, Connecticut.*

MAKE THIS COMPARISON AND SEE WHY

ROGERS PHENOLIC SHEET MOLDING MATERIALS	CONVENTIONAL HIGH IMPACT PHENOLICS
Low bulk factor of 1½ to 1	High bulk factor of 10 or 12 to 1
Low cost shallow molds	Expensive deep molds
Preforms can be blanked and pre-drilled for accurate location with inserts	Volumetric loading or hand preforming makes for difficulty in locating material with inserts
Preforms blanked from sheets of uniform thickness form mold charges of exact weight	Mold charges difficult to measure — require exact weighing to avoid over- or under-charging
Fast, uniform preheating	Slower, less uniform preheating
Good to excellent moldability	Poor to fair moldability
Low tooling cost, simplified production molding, minimum rejects, low unit parts cost	High tooling cost, tricky, expensive molding operations, high reject rate, high unit parts cost



ROGERS CORPORATION

ROGERS, CONNECTICUT

PRODUCTS

DUROIDS—for Gaskets, Filters, Electronic Devices, etc.
SHOE MATERIALS—for Counters, Midsoles, Liners, etc.
ELECTRICAL INSULATION—for Motors, Transformers, Generators, etc.
PLASTICS—Special Purpose Molding Compounds and Laminates.

SERVICES

FABRICATING—including Combining, Coating, and Embossing.
DEVELOPMENT—Research and Engineering of New Materials, Parts, and Products.

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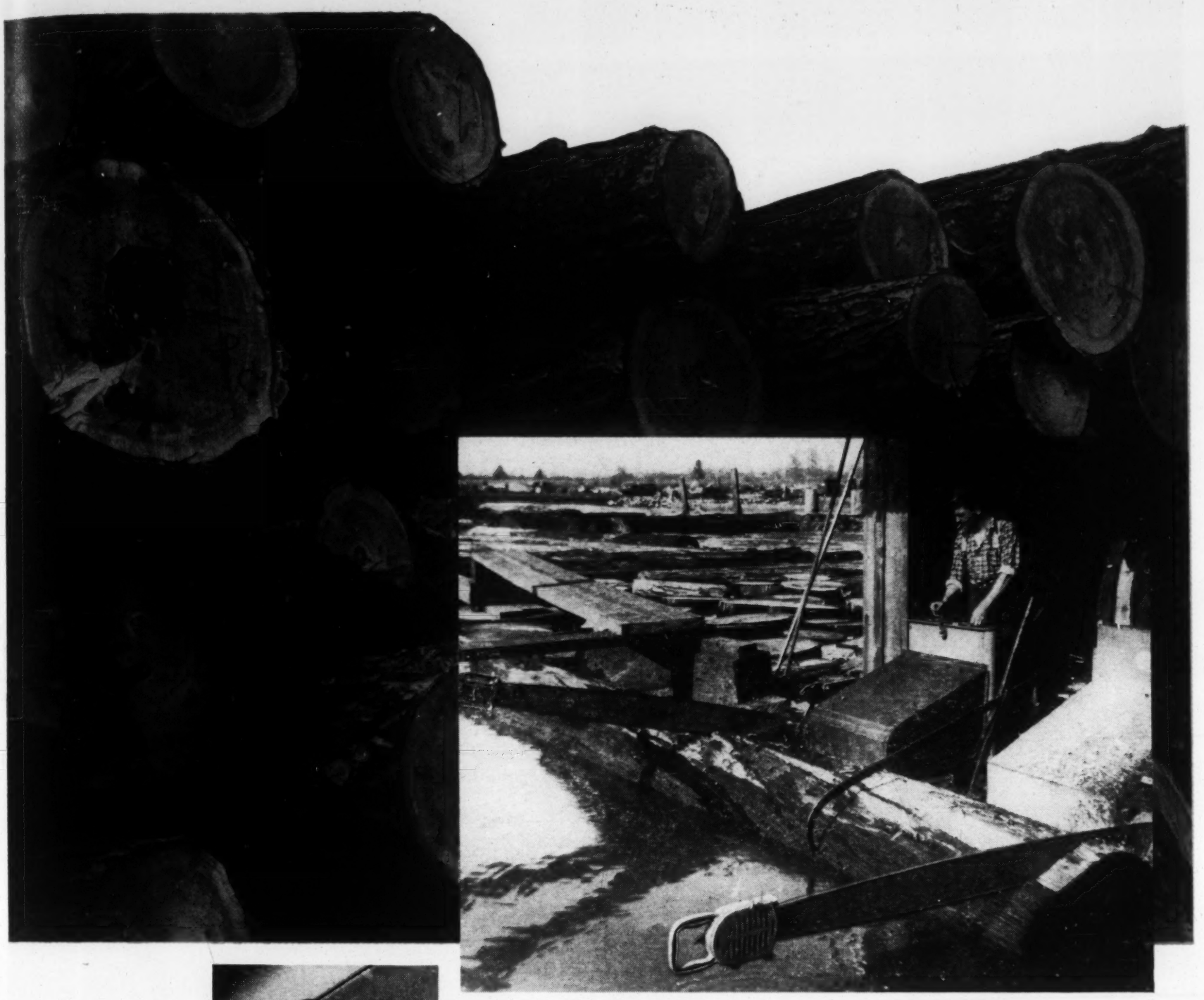
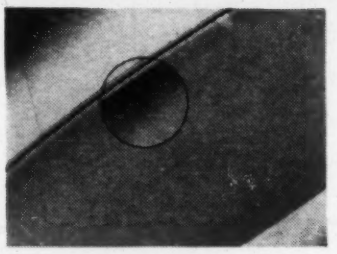


▲ L-M pond-type chain saws "bucking" log for a veneer plant.



◀ Close-up of MAX-EL alloy steel chain saw bar, showing depth of heat treatment for tougher, longer-lasting bars.

it takes MAX-EL Alloy Steel to take a beating like this

Ram the flying teeth of a chain saw against a heavy log – and watch the sawdust fly! But don't forget – backing up that speeding chain is a bar that has to absorb all the shock . . . yet keep the chain lined up accurately, dependably.

That's a big reason why leading chain saw manufacturers, like L-M Equipment Company, Portland, Oregon, specify Crucible MAX-EL® alloy steel for chain saw bars.

And there are other reasons, too. For MAX-EL is not only tough, wear-resistant and dependable . . . but it also shows outstanding response to heat treatment . . . excellent machinability . . . high uniformity . . . minimum distortion. It's these qualities that permit L-M to machine their saw bars first – *then* give them a graduated heat treatment that insures toughness at the edges . . . flexibility in the main section.

If your product requires a tough, machinable, non-deforming alloy steel – MAX-EL is for you. Try it. To see what information is available on MAX-EL – or *any* Crucible special steel – get your copy of the "Crucible Publication Catalog." Write *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

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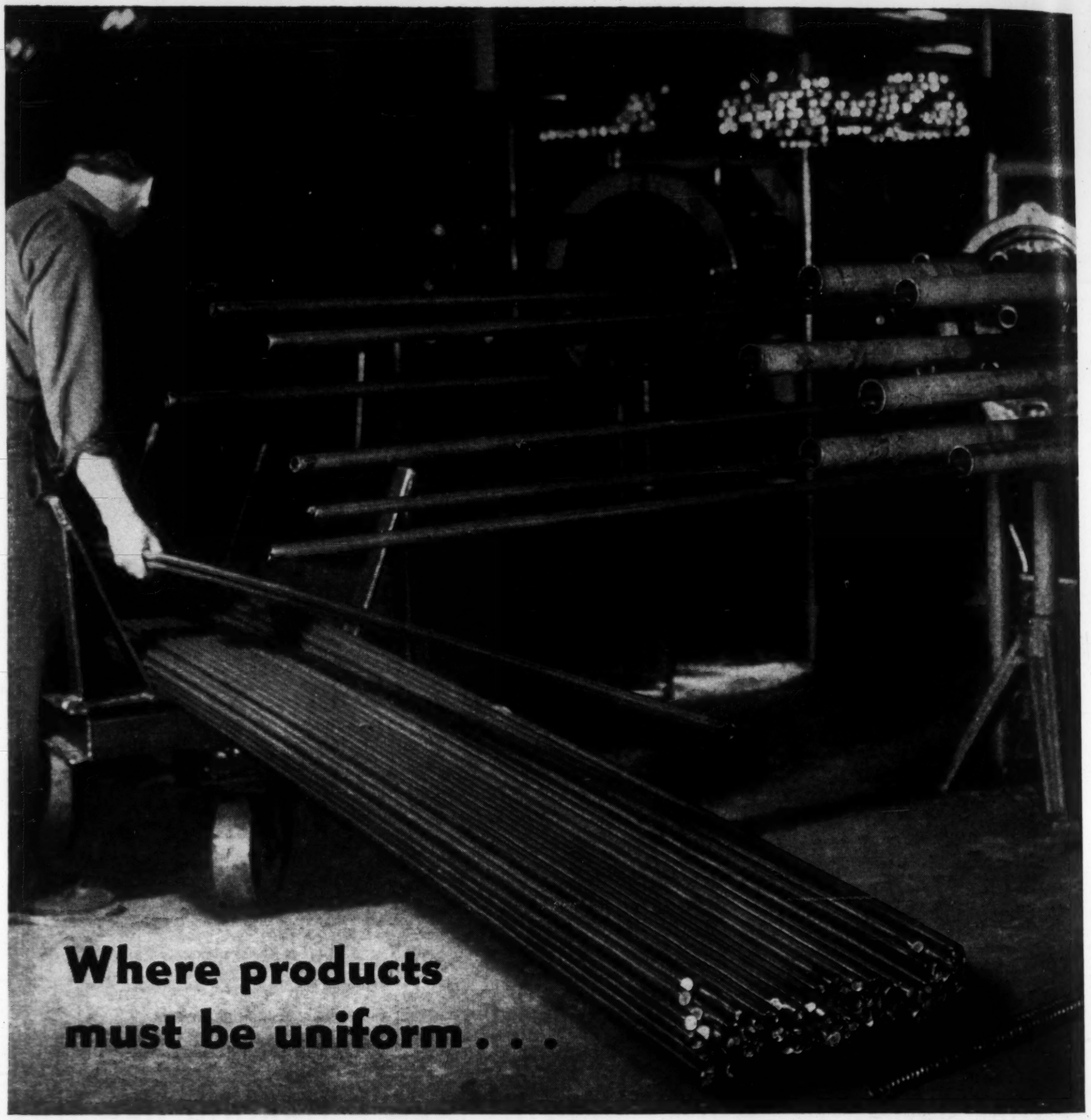


SPECIFY

Youngstown

COLD FINISHED CARBON AND QUALITY YOUNGSTOWN SERVICE ALLOY STEEL BARS

●It takes steel bars of uniform quality to turn out uniform products. That's why so many shops prefer Youngstown Cold Finished Carbon, Yolead and Alloy Steel Bars.

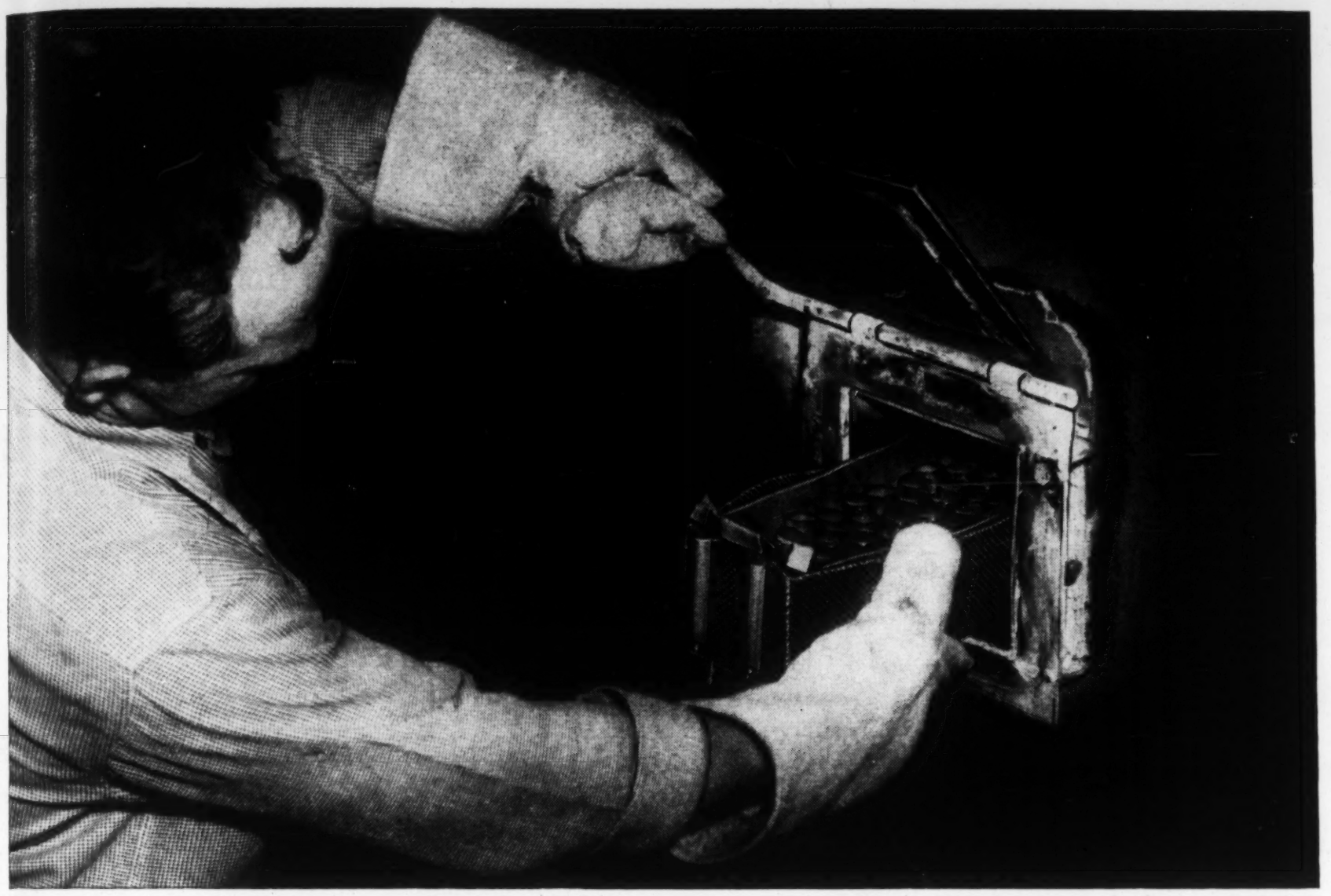
With Youngstown, uniformity starts in the Bessemer or Open Hearth. It is maintained throughout manufacture by men trained to work to exact specifications, checked at every step by close inspection. The name Youngstown is your best assurance of uniformity in screw machine stock.

THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

General Offices: Youngstown, Ohio - Export Office: 500 Fifth Avenue, New York 36, N. Y.

SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - BAR SHAPES - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - RAILROAD TRACK SPIKES

For more information, turn to Reader Service Card, Circle No. 317



720 Hours at 2300 Deg. F ...Didn't Hurt This Muffle

Continuous exposure at 2300 deg. F had little effect on a muffle made of HASTELLOY alloy X and used in this electric annealing furnace. The muffle was subjected to the intense heat for an entire month, 24 hours a day. After this extended service it was examined, found to be in excellent condition, and put back in service.

Actually, HASTELLOY alloy X solved a dual problem for this Company. The muffle is used in a furnace for annealing cold-drawn parts. Periodically, it is used for annealing superalloy parts at 2300 deg. F. Most of the time, however, it is used to anneal stainless steel parts at lower temperatures. Other materials were either inadequate for this service or too costly. Only HASTELLOY alloy X could handle both conditions economically.

HASTELLOY alloy X is a wrought high-temperature alloy with excellent strength and oxidation resistance to 2300 deg. F. For a copy of a booklet describing HASTELLOY alloy X, get in touch with the nearest sales office listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works, Kokomo, Indiana

Sales Offices

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"Haynes" and "Hastelloy" are registered trade-marks of Union Carbide and Carbon Corporation.

For more information, turn to Reader Service Card, Circle No. 364

WHEN YOU THINK OF COPPER

think of HUSSEY COPPER

AND YOU'LL ENJOY THESE IMPORTANT ADVANTAGES

1. **Lifetime durability and good appearance**
2. **Ease of fabrication by almost all known methods**
3. **Excellent electrical and thermal conduction properties**
4. **Ready availability that recommends Hussey Copper as standard**

Hussey Copper offers you all these features plus dependable top quality and uniformity that makes it advantageous to always specify "Hussey Copper." Mill service is available on mill-run quantities including finishing services such as shearing, slitting or special heat treating. For stock items call on any of the seven complete Hussey Copper Warehouse stocks listed below.

HUSSEY

Sheet • Strip • Coils
Rods • Wire • Tubing
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C. G. HUSSEY & COMPANY
(Division of Copper Range Co.)
ROLLING MILLS AND GENERAL OFFICES
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Seven Convenient Warehouses
• CHICAGO • NEW YORK
• CINCINNATI • PHILADELPHIA
• CLEVELAND • PITTSBURGH
• ST. LOUIS

For more information, turn to Reader Service Card, Circle No. 335

Out of scores of possible materials CHRIS-CRAFT might have selected for their fin they chose...

Chris-Craft's new sports-boat, the "Cobra." Estimated speed: 50-55 m.p.h. Chris-Craft needed light weight with ample strength – found it in Nopco Lockfoam sandwiched between sheets of glass fiber. The fin's volume is 0.8 cu. ft.; its total foam weight is only 3.2 lb. This structure is rugged enough to stand up under rough handling and any undue stresses, and yet provides a plus in buoyancy.

NOPCO® LOCKFOAM

Nearly every week we hear of a new use in which our foamed-in-place cellular plastic, Lockfoam, is helping some manufacturer to achieve durable construction at low production costs. This time it's in the "fin" which adds distinction to the new Chris-Craft "Cobra."

Lockfoam's ease of handling, as well as its pour-in-place technique, offers important advantages and economies over other structural materials which must be cut and shaped to fit a given cavity.

By using Lockfoam, therefore, labor costs and waste of material are drastically reduced; a further saving is effected by eliminating the need for expensive equipment.

Each of Lockfoam's 50 different formulations is highly consistent and reproducible. The technical service staff of Nopco's Plastics Division is at your service, to aid you in selecting, formulating, and applying Lockfoam to bring you the greatest benefits from its outstanding advantages. Write today for the Nopco Lockfoam booklet. Nopco Chemical Co., 328 Stier St., Harrison, New Jersey.

Where Can YOU Best Use These Properties?

Near-perfect Radar Transmission

Ease of Fabrication
It's "poured-in-place"

Great Strength with Light Weight

Excellent Electrical Properties
6 lb/cu ft Lockfoam tested at 9.375 KMC
Dielectric Constant 1.05
Loss Tangent .0005

Good Thermal Insulation
"K" Factors
.018 at 8 lb/cu ft
to .025 at 11 lb/cu ft

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From 2 to 35 lb/cu ft

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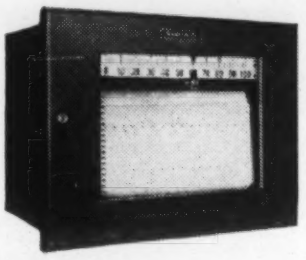

Choose *ElectroniK* Circular Chart Controllers for ease of scale reading . . . convenient daily charts; in a full range of electric and pneumatic control forms.

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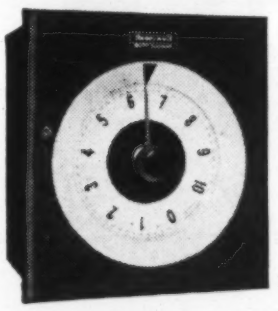
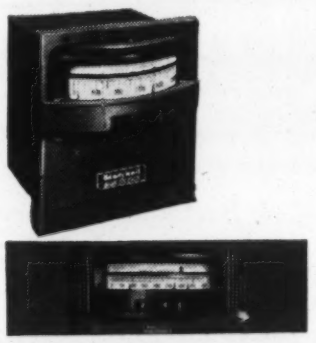


Choose *Pyr-O-Vane* Controllers where you don't need a record but do need precise vane type snap action electric control by a millivoltmeter instrument...also available with pulse-type time proportioning action, in both vertical and horizontal models.

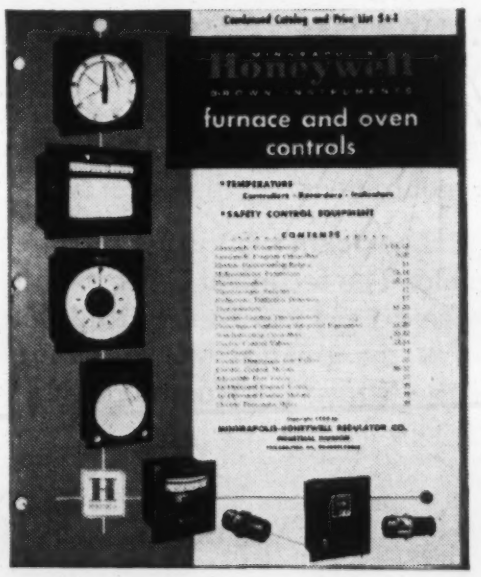


Choose *Protect-O-Vane* Controllers for simple, dependable excess temperature cut-off protection...can be used with any temperature control to prevent furnace shut downs and loss of production.

• • •

And for all your pyrometer supplies, investigate the convenience and economy advantages of the HSM Plan.

Flexibility for parts carburizing at Caterpillar®— in *ElectroniK*



Detailed information on all Brown instruments for regulating heat-treating equipment is contained in Catalog 54-1, "Furnace and Oven Controls" . . . complete with up-to-date prices. Write for your copy today . . . or get one from your local Honeywell sales engineer next time he calls.

Track link bushings for Caterpillar Crawler Tractors . . . famous for 50 years . . . are carburized in these Surface Combustion furnaces, under precise time-temperature control by ***ElectroniK*** *instruments on the panels in the background.*

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The wide line of Honeywell instrumentation includes controlling, recording and protective equipment applicable to literally any kind of heat-treating furnace. For a discussion of your individual requirements, call your nearby Honeywell sales engineer . . . he's as near as your phone.

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21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
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Information on Advertisement No.

301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
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New Literature

Nylon Resin. E. I. du Pont de Nemours & Co., Inc., Polychemicals Div., 54 pp. Describes "Zytel", a nylon resin supplied as molding powder for conversion into wire-coatings, rods and other extruded shapes. Final products have outstanding toughness, abrasion resistance, form stability at high temperatures, and chemical resistance. (2)

Cellulose Ester Plastics. Eastman Chemical Products, Inc., 44 pp. Data on physical properties of "Tenite" in types, formulas and flows supplied for molding and extrusion. Applications included. (3)

Nickel Alloyed Cast Iron. International Nickel Co., 64 pp, illus, No. A-71. Applications of "Ni-Resist" corrosion resistant nickel alloyed cast iron. Gives corrosion data, mechanical and physical properties. (4)

Chromium-Nickel Alloy Steel Powders. Metal Hydrides, Inc., 4 pp. Reprint on use of pre-alloyed chromium-nickel powders for strong, wear resistant products. (5)

Leaded Carbon Alloy Steel. Joseph T. Ryerson & Son, Inc., 4 pp, illus. Describes fast machining leaded alloy steel supplied in both annealed and quenched-and-tempered condition. (6)

Zinc-Coated Steel. Sharon Steel Corp., 12 pp, illus. Describes hot dipped, zinc-coated steel possessing high resistance to atmospheric corrosion and providing suitable surface for paint or baked enamel. (7)

Powder Metallurgy. F. J. Stokes Machine Co., 36 pp, illus. Clear, concise discussion of powder metallurgy including summary of process, applications, mechanical characteristics of powder metal parts, and design considerations. (8)

Felt. Western Felt Works, 28 pp. Discussion of felt, its applications, composition, specifications and testing methods. (9)

Coating Resins. Barrett Div., Allied Chemical & Dye Corp., 8 pp. Brief description of various coating resins. Solution and solids characteristics given. (10)

Stainless Fasteners. Allmetal Screw Products Co., 8 pp, No. P25A. Lists available stainless fasteners. Includes style and size data on stainless screws, bolts, nuts, washers, rivets, etc. (11)

Aluminum Finishes. Aluminum Co. of America, 48 pp, illus. Discusses methods in which appearance and performance characteristics of aluminum may be changed. Basic characteristics of aluminum finishes includes texture, reflection, durability and surface hardness. Finishing methods and applications of specific finishes to products and structures are given. (12)

Centrifugal Pumps. American - Marsh Pumps, Inc., 6 pp, illus, No. 350-19. Describes pumps for high static heads featuring single-stage, double-suction centrifugal design. (13)

Powder Metallurgy. Amplex Div., Chrysler Corp., 50 pp. No. F-55. Comprehensive manual on powder metallurgy. Separate sections cover bearings, component parts, and filters. Other subjects include design, loads and speeds, installations, wall thickness, magnetic properties, etc. (14)

Automatic Press for Powdered Metal. Arnhold Ceramics, Inc., 2 pp, illus. Describes press emphasizing device that provides uniform compression despite wide variations in cross sections of intricate parts. (15)

Dielectrics. Antara Chemicals, 15 pp. Describes plastic that combines high heat distortion point with ability to maintain property at high temperatures and high frequencies. (16)

Epoxy Resins and Hardeners. Bakelite Co., 16 pp, illus. Describes use of epoxy resins for tools, dies, jigs, adhesives, etc. Separate section devoted to release agents for molds. (17)

Grating Spectrographs. Bausch & Lomb Optical Co., 8 pp, illus, No. D-272. Describes spectrograph with two gratings for greater dispersion flexibility. (18)

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Information on Advertisement No.

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Chromium-Molybdenum Electrodes. Champion Rivet Co., 11 pp, plus graphs. New welding electrodes for chromium-molybdenum alloy steels. Complete welding data including physical properties, chemical analyses of weld deposits, mechanical properties and welding technique analysis. (20)

Impact Styrene Sheet. Chicago Molded Products Corp. Describes high-gloss surface finish for impact styrene sheet. Includes applications. (21)

Precision Investment Castings. Crucible Steel Co. of America, 16 pp, illus. How to precision cast unmachinable high-temperature alloys to close tolerance through "lost wax" method. (22)

Zinc Phosphate Coatings. Detrex Corp., 8 pp, illus. Phosphate coatings for protection of paint finishes under severe corrosion conditions. (23)

Electrical Insulating Tapes. Dobeckmun Co., 4 pp, illus. Describes various electrical insulating tapes made from Mylar, cellulose acetate, cellulose acetate butyrate or cellulose triacetate bases, either as is, or laminated to other materials. Typical applications shown. (24)

Sintering Furnaces. Drever Co., 12 pp, illus, No. B-101. Describes types of furnaces for sintering metal powder products. (25)

Elastomers. E. I. du Pont de Nemours & Co., Inc., Elastomers Div. Introduces "Hypalon", a heat and corrosion resistant elastomer for use as protective coating for rubber, wood and metal, gaskets and packings; tank linings and coated fabrics. (26)

Centrifugal Casting. Electric Steel Foundry Co., 12 pp, illus. How to reduce costs in casting stainless and high alloy steels into hollow circular or cylindrically shaped products. (27)

Weldments. Graver Tank & Mfg. Co., Inc., 16 pp, illus. Describes company's welding facilities. (28)

Bushings. Groov-Pin Corp. Self tapping insert used as original equipment and for salvage and repair of stripped threads. (29)

Aluminum Forgings. Harvey Aluminum Div., 12 pp, illus. Describes aluminum press forgings, impact extrusions, and hand forgings. Outlines mechanical properties of aluminum forging alloys and summarizes typical forging applications. (30)

Vacuum Metallizing Equipment. High Vacuum Equipment Corp., 8 pp, illus, No. 551. Describes company's mass production and experimental type metallizing units. Includes description of vacuum metallizing process. (31)

Blind Rivet. Huck Mfg. Co., 4 pp, illus. Describes drive pin blind rivet. Specifications given. (32)

Glass Fiber Insulation. LOF Glass Fibers Co., 4 pp, illus. Describes low density, resilient glass fiber insulating material. (33)

Sintering Furnaces. Lindberg Engineering Co., 8 pp, illus, No. 230. Describes various types of sintering furnaces. (34)

Alkali Hardwood Lignin. Mead Corp., 14 pp. Outlines properties, industrial applications and chemical modifications of "Meadol". (35)

Aluminum Bronze Electrode. Metal & Thermit Corp., 20 pp, illus. Describes aluminum bronze coated electrode providing high strength, corrosion-resistant deposit for arc welding manganese bronze castings and brass sheets or plates. (36)

Adhesives, Coatings and Sealers. Minnesota Mining & Mfg. Co., 4 pp, illus. Describes use of adhesives, coatings and sealers for joint-sealing, bonding and protecting sheet metal in manufacturing and construction. (37)

Brass Powder Sintering. New Jersey Zinc Co., 4 pp, illus. Outlines applications for brass powder sintered parts emphasizing tripper flywheel in advanced-type camera. (38)

X-ray Analysis. North American Philips Co., Inc., 7 pp. Explains difference in X-ray powder camera, diffractometer and spectrograph equipment and techniques. Outlines specimen preparation, application fields, calibration and selection of analyzing crystals for spectrograph work. (39)

Brushing. Osborn Manufacturing Co., 10 pp, illus. Describes advantages of industrial brush finishing operations through case histories. (40)

Carbon and Low Alloy Steel Castings. Quaker Alloy Casting Co. Reference chart covers specifications, analysis, physical properties and heat treatment data for carbon and low alloy steel castings. (41)

Molded Rubber Products. Roberts Toledo Rubber Co., 16 pp, illus. Describes company's facilities for producing molded rubber parts. (42)

Paper Chemicals. Rohm & Haas Co., 2 pp. Revised price list for paper chemicals incorporating reductions in price of several products. (43)

Burners. Selas Corp. of America, 12 pp, illus, No. S-1032. Describes device for accelerated heat transfer without flame impingement for gas-air combustion. (44)

Particle Size Distribution Analysis. Sharples Corp., 10 pp, illus, No. 101. Describes micromerograph which provides rapid particle size distribution analyses of powered materials. (45)

Wire Processing. Sylvania Electric Products, Inc., 12 pp, illus. Describes facilities for manufacture of fine wire and ribbon, wire and ribbon parts, and small parts plating. Chemical composition charts of materials used are included (46)

Temperature-Monitoring System. Thermo Electric Co., Inc., 8 pp, illus, No. 70. Describes monitoring system in which lights indicate temperature conditions at various points. (47)

Electrical Laminations. Thomas & Skinner Steel Products, Inc., 40 pp, No. L-355. Product line drawings, graphs, and charts provide information on special and standard electrical laminations including test procedures. (48)

High Strength Structural Steel. U. S. Steel Corp., 174 pp. "Design Manual for High-Strength Steels". Available free to qualified personnel. Request on company letterhead direct from U. S. Steel, 525 William Penn Place, Pittsburgh 30, Pa.

Die Steels for Cold Work. Vanadium-Alloys Steel Co., 22 pp, illus. Details, uses, composition and heat treatment of die steels for cold work. (50)

Brazing and Processing Stainless Steel. Wall Colmonoy Corp., 4 pp, illus. How to braze stainless steels and special alloys with "Nicrobraz", a heat and corrosion resistant alloy. (51)

Thermometals and Special Alloys. H. A. Wilson Co., 2655 U. S. Route 22, Union, N. J., 192 pp., price $3.00. New Blue Book on thermostatic bimetals, sintered metals, electrical contact materials, composite and laminated metals and special alloys. Provides design data, graphs formulae and properties and applications of hundreds of materials. Also lists production executives, purchasing agents in the field. Write direct to Wilson on company letterhead.

Other Available Literature

Irons and Steels • Parts • Forms

Stainless Steel. Allegheny Ludlum Steel Corp., 34 pp, ill. Use of stainless steel in pulp and paper industry. Includes a special stainless finder chart which indicates the types of stainless available and their uses in the paper industry. (60)

Stainless Steel Powders. Alloy Metal Powders, Inc., 4 pp, ill. How to produce sintered parts from stainless steel powders. Includes graphs of analysis, physical properties, compacting pressures, etc. (61)

Precision Castings. Austenal Laboratories, Inc., Microcast Div., 16 pp, ill. Describes Microcast Process for manufacture of precision cast parts, including specifications and explanation. (62)

Steel Tubing. Avon Tube Div., 8 pp, illus. Gives fabrication and application data for thin-walled steel tubing. (63)

Wire Parts and Metal Stampings. Art Wire & Stamping Co., 4 pp, ill, No. 875. Illustrates a variety of wire parts and small metal stampings that this company can produce. (64)

Low-Alloy Steel. Bethlehem Steel Co., 66 pp, ill, No. 353. Properties and features of Mayari*R steel for use in applications requiring high strength and good wear and corrosion resistance. (65)

Welded Steel Tubing. Brainard Steel Co., Tubing Div., 8 pp, ill. Shows facilities for manufacturing welded steel tubing, its applications, fabrications, specifications. (66)

Manufacturers' Literature

Lead Treated Steels. Copperweld Steel Co., 8 pp, ill. Discusses lead addition to steel and its effect on machinability. (67)

Stainless Steel Tubing and Pipe. Damascus Tube Co., 8 pp, ill. Profusely illustrates the manufacturing process of stainless steel tubing and pipe offered by Damascus. (68)

Gray Iron Castings. Dostal Foundry Machine Co. Permanent mold gray iron casting facilities. (69)

Investment Castings. Engineered Precision Casting Co., 8 pp, ill. Complete data on EpCo precision investment castings of stainless steel, alloy tool steel, beryllium-copper and most metals that can be melted. (70)

Hot Work Steel. Firth Sterling, Inc., 2 pp, No. 10-280. Describes C.Y.W. Choice, a chromium alloy hot-work steel developed for dies and other tools subject to heavy pressure at high temperature. (71)

Flexible Metal Hose. Flexonics Corp., 16 pp, ill. Catalog of expansion joints and flexible metal hose. (72)

Gray Iron. Gray Iron Founders' Society, Inc., Data Sheet and 12 pp booklet. Data sheet summarizes gray iron specifications. Booklet contains articles on how and when to use gray iron, and its adaptability for casting. (73)

Perforated Materials. The Harrington & King Perforating Co., 5670 W. Fillmore St., Chicago 44, Ill., No. 62. Data on fabrication methods, how to order, types of perforation and uses of perforated materials. Write direct to Harrington & King on company letterhead.

Steel Alloys. Jones & Laughlin Steel Corp., ill. Outlines properties, composition. Includes applications, case histories and heat treatment of steel alloys. (74)

Heavy Steel Heads. Lukens Steel Co., 4 pp. Stocklist of company's supply of heads. (75)

Malleable Castings. The Malleable Founders' Society, 8 pp, ill, No. 47. Analysis of good practice in tolerances and specifications of malleable castings. (76)

Quality Controlled Iron. Meehanite Metal Corp., 12 pp, ill. Applications of Meehanite in cams, camshafts and crankshafts. (77)

Threaded Stampings. Mohawk Mfg. Co., 2 pp, No. 851. Illustrates variety of products produced by Mohawk's stamping processes, guaranteeing uniform threaded parts with uniformly threaded holes. (78)

Metal Powders. Plastic Metals, Div. of National Radiator Co., 4 pp, ill, No. 1 Powdered iron, nonferrous and alloyed powders. Variety of grades for all powder metal applications. (79)

Seamless Steel Tubing. National Tube Div., U. S. Steel Co. Explains time-and cost-cutting fabricating applications of this company's Shelby seamless tubing. (80)

Steel Tubing. Rochester Products Div., General Motors, 12 pp, ill, No. 271. Features typical applications of GM tubing made in both single and double walls of steel. (81)

Roll Formed Shapes. Roll Formed Products, 24 pp, ill, No. 1053. Shows production procedures and advancements in roll forming shapes from ferrous and nonferrous metals. (82)

Precision Investment Casting. Alexander Saunders & Co., 12 pp, ill. Advantages in comparison with conventional methods of producing precision investment castings, technique, and equipment and supplies needed. (83)

Spun Metal Parts. Spincraft, Inc., No. 3. Data book on metal spinning and fabricating gives data on process and help in designing for economical production. (84)

Steel Hydraulic Tubing. Summerill Tubing Co., Div. Columbia Steel and Shafting Co., 8 pp, ill. Discusses tubing requirements, specifications for hydraulic applications, and advantages of steel seamless tubing. (85)

Deep-Drawn Shapes. Roland Teiner Co., 8 pp, ill. Reprint illustrates the many deep-drawn simple and intricate shapes produced by the new Hydroform process. (86)

Graphitic Steel. The Timken Roller Bearing Co., Steel & Tube Div. Data on properties and applications of graphitic steels. (87)

Coated Strip Steel. Thomas Strip Div., Pittsburgh Steel Co., 20 pp, illus, No. TS-101. Strip steel pre-coated with zinc, copper, brass, lead alloy, nickel or chromium, natural planished or buffed finishes and rolled in patterns. Booklet includes 8 samples. (88)

Alloy Steel Castings. Unitcast Corp., 2 pp. Sepecifications, characteristics and uses of T-loy 42, alloy steel castings. (89)

Pipe and Tubing. The Wallingford Steel Co., 8 pp, ill. Stainless, carbon and alloy steel tubing for ornamental, mechanical, pressure, sanitary and aircraft use in size range from ¼-in. to 3-in. O.D. (90)

Stainless Steel Sheet and Strip. Washington Steel Corp., 4 pp. Includes types, uses, physical properties and specifications of MicoRold stainless steel sheet and strip. (91)

Stainless Steel Castings. Waukesha Foundry Co., 4 pp, ill, No. WF 6. Discusses the facilities of this company for producing corrosion resistant high alloy, heat resistant stainless steel castings. (92)

Screw Machine Products. Westfield Metal Products Co., 4 pp, ill. Describes facilities for the production of a variety of machines, nuts and screw machine products. (93)

Magnetic Alloys. Westinghouse Electric Corp., 8 pp, No. TD-52-100. Complete data on a variety of magnetic alloys produced by this company includes applications and 15 core loss and magnetization curves. (94)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 67 and 68

Metal Powder Parts. American Sintered Alloys Div., Yale & Towne Mfg. Co., 6 pp, ill, No. 352. Shows a variety of ferrous and nonferrous metal powder parts fabricated by this company. (95)

Mechanical Tubing. Youngstown Sheet & Tube Co., 4 pp, ill. Features size and wall thickness of a complete line of Yoloy electric weld mechanical tubing. (96)

Nonferrous Materials • Parts • Forms

Wear Resistant Materials. American Brake Shoe Co., 48 pp, ill. Catalog of representative products; castings, bearing materials, forgings, sintered metals and industrial equipment. (97)

Bronze Bushings, Bearings, Etc. American Crucible Products Co., 12 pp, ill. Technical data on a variety of Promet bronze bushings, bearings, bar stock and babbitt metal available in a series of standard formulas. (98)

Bronze Casting Alloys. American Manganese Bronze Co., 50 pp, ill. Revised edition gives composition, characteristics and applications of the principal copper alloys used to make castings. (244)

Vacuum Die Casting. Aurora Metal Co., 8 pp, ill. Describes process for aluminum bronze and silicon bronze. Applications, physical and chemical specifications. (99)

Small Tubular Parts. The Bead Chain Mfg. Co. Describes Multi-Swage Process for economically custom producing small mechanical parts up to ¼-in. dia. and 2-in. length. (100)

Bimetals. W. M. Chace Co, 36 pp, ill. Describes and explains 22 uses of bimetals as actuating elements in temperature responsive devices. (101)

Phosnic Bronze. Chase Brass & Copper Co. Bronze alloy for jobs requiring high-strength metal with good conductivity. (102)

Metallic Abrasives. Cleveland Metal Abrasive Co., 16 pp, illus. Discusses three types of metallic abrasives and selection of abrasion method. (103)

Zinc Phosphate Coatings. Cowles Chemical Co., 4 pp. Properties of amorphous and crystalline non-sludging zinc phosphate coatings. (104)

Powder Metallurgy Parts. Detroit Sintered Metals Corp., 4 pp, ill. Lists metal specifications for sleeve bearings, bushings and intricate shapes. (105)

Rings. Dresser Mfg. Div., 4 pp, illus. Heavy industrial equipment fabrication from welded rings. (106)

Short Run Stampings. Federal Tool & Mfg. Co., 4 pp, ill, No. 201. Short run, close tolerance stamping with low cost dies. (107)

Aluminum Alloy. Frontier Bronze Corp., 24 pp, illus. Describes Alloy "40-E", a high strength alloy containing zinc with magnesium, titanium and chromium, which needs no heat treatment. Separate data sheets on specifications, composition and properties. (108)

Laminated Metals. General Plate Div., Metals & Controls Corp., 4 pp, ill, No. 1a. Properties and uses of various laminated silver contacts. (109)

Metal Stampings. Geometric Stamping Co., 4 pp, ill. Suggestions for cost savings through conversion from castings to stampings. (110)

Investment Castings. Gray-Syracuse, Inc., 4 pp, ill. Parts of precision cast brass bronze, beryllium copper and steel. (111)

Zinc Alloy Small Parts. Gries Reproducer Corp., 4 pp, ill. Standard zinc alloy small parts ranging from jewelry findings to hardware products. Outline of company's contract manufacturing services. (112)

Copper and Brass Tubing. H & H Tube & Mfg. Co. Describes a complete line of seamless braze and lock seam copper and brass tubing. (113)

Aluminum Extrusions. Harvey Aluminum Div., Harvey Machine Co., 8 pp, ill. Properties, characteristics and application of a variety of aluminum extrusions produced by this company. (114)

Double Headed Parts. John Hassall, Inc. Catalog shows numerous double headed parts, indicating applications and suggesting other applications of double heading operations. (115)

Long Wearing Machine Parts. Haynes Stellite Co., 23 pp, ill. Booklet describes a few of the many machinery parts made of Haynes alloys. Also contains over 60 tables and photographs showing some of the sizes and shapes in which these alloy parts are being used. (116)

Aluminum Alloy Selector. Howard Foundry Co. A slide rule type selector for permanent mold cast aluminum alloys and sand cast aluminum alloys. Write on company letterhead direct to Howard Foundry Co., 1700 N. Kostner Ave., Chicago 39, Ill.

Laminated Metals. Improved Seamless Wire Co., Inc., 6 pp, ill. Describes the importance and applications of laminated metals to modern industry. (117)

Precision Die Castings. The Jelrus Co., Inc., 4 pp, ill. Illustrates cost savings in parts production through use of nonferrous precision die casting methods. (118)

Bearing Design. Johnson Bronze Co. Data sheets give information on proper design of bearings, including details such as the lubrication of sleeve type bearings. (119)

Screw Machine Parts. Kaiser Aluminum & Chemical Corp. Slide-rule calculator for estimating amount of aluminum stock needed for screw machine parts. (120)

Die Castings. Litemetal DiCast, Inc., 12 pp, ill. How to select best light metal for die casting. Shows facilities for producing light metal pressure die castings. (121)

Lithium Metals and Compounds. Lithium Corp. of America. Data sheets on properties and uses of lithium metal and organic and inorganic lithium compounds for metal treatment, ceramic modifications, welding, etc. (122)

Tin. The Malayan Tin Bureau. "Tin News," a monthly publication of the Malayan Tin Bureau, reviews market situation, tin uses and political developments affecting the supply of tin. (123)

Aluminum Castings. The Permold Co., ill. Shows how continuous scientific control of Permold aluminum casting quality, to specifications, saves time and money. (124)

Aluminum Extrusions. Precision Extrusions, 12 pp, ill. Describes aluminum extrusion process with tables of physical properties and recommended applications. (125)

Bushings. Randall Graphite Bearings, Inc., 12 pp, ill, No. 100. Complete price list of bronze bushings and specially grooved bushings; specifications of bored and solid bronze bars. (126)

Condenser Tubes. Revere Copper and Brass, Inc., 28 pp, ill. Detailed discussion of ways to make condenser tubes last longer, what they are made of, and new developments in materials. (127)

Aluminum Appliance Parts. Reynolds Metals Co., 20 pp, illus. Discusses use of aluminum parts in appliances such as refrigerators, air conditioners, washers and dryers. (245)

Centrifugal Castings. Sandusky Foundry & Machine Co., 6 pp, ill. Specification chart for ferrous and nonferrous alloys for centrifugal castings. (128)

Strip and Sheet Brass. Scovill Mfg. Co., 4 pp, ill. Continuous-cast strip and sheet brasses and bronzes. (129)

Precision Casting. Thompson Products, Inc., Metallurgical Products Div., 8 pp, ill, No. MP-53-1. Discusses the Intricast process of precision casting any castable metal or alloy. (130)

Formed Tubing. Tube Reducing Corp., 4 pp, ill. Stresses economic advantages of hot-forming complex tubular parts in the plant in which the precision tubing is made. Describes this company's facilities. (131)

Aluminum Wire. U. S. Rubber Co., 30 pp, tables. A handbook describing the uses and properties of aluminum for power and lighting wire. (132)

Spun Tubing. Wolverine Tube Div., 28 pp, ill. Advantages and numerous applications of this firm's nonferrous Spun End Tube Process. (133)

Nonmetallic Materials • Parts • Forms

Plastic Molding. Ackerman Plastic Molding Div., 4 pp, ill. Long run production of plastic parts by compression of plunger molding. (134)

Silicone Rubber. Acushnet Process Co., 8 pp, ill, No. B. Describes method of custom-compounding silicone rubber. Gives property ratings, molding techniques, mold design and design specifications. (246)

Lubrication. Alpha Corp., 4 pp. Describes principle of lubrication by solids and role of molybdenum disulfide in this process. (136)

Wool Felt. American Felt Co. Includes Dept. of Commerce bulletin Commercial Standard 185-52 Wool Felt. 47 reference samples of industrial felts. (137)

Extruded Plastics. Anchor Plastics Co., 12 pp, ill. Applications of thermoplastic rods, tubes and shapes. Summary of properties of plastics materials with usage table. (138)

Gasket Materials. Armstrong Cork Co., 24 pp, ill. Complete data on various cork and rubber gasket materials made to meet government specifications. (139)

Sponge Rubber. Automotive Rubber Co., Inc., 4 pp, illus. Closed-cell sponge rubber material which is moisture proof, soft, shock-absorbent and light. Specifications and applications given. (140)

Gaskets, Packings, Etc. Auburn Mfg. Co., 3 pp, ill. Discusses the various products produced by this company, including gaskets, packings, washers, spacers, seals, shims and bushings. (141)

Thermoplastics. Bassons Industries Corp., 12 pp, ill. Complete data on reinforced and formed plastics. Illustrates processing facilities. (142)

Ceramic Coating. California Metal Enameling Co., 4 pp, ill. Ceramic coatings for metals for high temperature service. Includes sample of ceramic coated 0.001-in. stainless and steel foil. (143)

Natural and Synthetic Rubber Products. H. O. Canfield Co., 80 pp, illus. Catalog of standard rubber components, including grommets, bushings, O-rings, bumpers, tips and mechanical parts of natural and synthetic rubber. (144)

Plastic Pipe. Carlon Products Corp., 4 pp, ill. Contains factual informative answers to most frequently asked questions about carbon flexible plastic pipe and carbon rigid pipe. (145)

Resin-Bonded Laminates for Finishing. The Chemical Corp., 20 pp, ill, No. PD-1R353. Data sheets discuss a variety of tanks, ducts, hoods, stacks and waste pipe for corrosion resistant use. (146)

Thermoplastic. Colonial Plastics Mfg. Co., Industrial Div., 16 pp. Technical data on properties, available forms, fabrication and applications of Lucoflex, a rigid polyvinyl chloride. (147)

Vulcanized Fibre. Continental-Diamond Fibre Co., 12 pp, illus, No. DVF-55. Complete physical, chemical and electrical properties and other engineering data for vulcanized fibre parts, sheets, tubes and rods. (148)

Plastic. Crane Packing Co., 12 pp, ill, No. T-103. Complete data on Chemlon packings and gaskets fabricated from the new tetrafluoroethylene resin, Teflon. (149)

Plastics. The Dow Chemical Co., 20 pp, ill. Products, applications and technical services outlined in this brochure on Dow's line of plastics which includes Styron, Ethocel, Saran and Vinyls. Includes charts of properties, case histories of applications and description of engineering services offered by the company. (150)

Felt and Felt Products. Felters Co., 16 pp, ill. Includes properties, applications and specifications of felt as a design material and various felt products. (151)

Thermoplastic Resins. Firestone Plastics Co., Div. of Firestone Tire & Rubber Co., 20 pp, ill. Properties and use of Exon vinyl resins. Describes technical service facilities available (152)

Cast Wood. Forestrong Co., 4 pp, ill. Profusely illustrates and describes a wood fiber molding process. (153)

Manufacturers' Literature

Glass-Silicone Laminate. The Formica Co., 4 pp, ill. Glass-Silicone laminate for use in sealed, dry-type transformers. (154)

Reinforced Wood. Gamble Bros., Inc., 4 pp. Wood coated with high strength thermoplastic gives higher strength, wear, and impact resistance. (155)

Plastic Products. General American Transportation Corp., Plastics Div., 10 pp, ill. Brochure shows plant facilities for production from blueprint through assembly and packing. Also lists wide variety of this company's molded plastics. (156)

Rubber-Cushioned Parts. General Tire & Rubber Co., 12 pp, ill. Describes General Silentbloc method of mounting coupling or isolating moving machinery on rubber. Shows standard parts and specifications. (157)

Polystyrene Sheet. Gilman Bros. Co., 4 pp, ill. High impact polystyrene sheet for vacuum forming. Has five times the strength of general-purpose sheet. (158)

Reinforced Laminates. Glastic Corp., 8 pp, ill. Description, properties and performance comparison of plastics, polyesters reinforced with Fibreglas for heavy duty electrical insulation. (159)

Hycar Rubber. B. F. Goodrich Chemical Co., 22 pp, ill. Complete analysis of properties and uses of Goodrich oil and solvent resistant rubber. (161)

Polyvinyl Chloride Resin. Goodyear Tire & Rubber Co. Describes resin developed for extruded wire insulation materials. Properties and composition given. (162)

O-Rings. Goshen Rubber Co., Inc., 14 pp, ill. Tells where and how to use O-rings in engineering applications. Lists sizes, groove dimensions and compounds for all types of O-ring seals. (163)

Self-Lubricating Bushings. Graphite Metalizing Corp., 8 pp, ill, No. 108. Describes Graphalloy grades for bushings and electrical uses. Bearing design data included. (164)

Polyvinyl Chloride Resin. H. N. Hartwell & Son, Inc., 8 pp, ill. Sheet, bar stock list of nonplasticized polyvinyl chloride. (165)

Plastics. Heil Process Equipment Corp., 4 pp, ill, Vol. 4, No. 1. Suggests applications for Rigidon, a glass-reinforced plastic; Rigidin, a rigid vinyl plastic; and Rigidene, a polyethylene plastic. (166)

Plastisols. Houghton Laboratories, Inc., 4 pp, ill. Includes typical applications and specifications of the Hysol 3000 series of plastisols—dispersions of high molecular weight polyvinyl chloride resins in selected liquids called plasticizers. (167)

Molded Plywood. Keller Products, Inc., 12 pp, ill. Booklet describes standard and constantly used die shapes for molding plywood as an aid to designers of molded plywood shapes. (168)

Foam Polystyrene. Koppers Co., Inc., 10 pp, No. C-4-200-T. Describes expandable polystyrene beads and polystyrene foam. Includes physical and chemical property listings, suggested applications, molding data and instructions for use of adhesives with the material. (169)

Electrical Insulation. Louthan Mfg. Co., 13 pp, ill, No. 49-E. Uses and specifications of Louthan insulations in mechanical, electrical, thermal and electronic fields. (170)

Refractory Porcelain. McDanel Refractory Porcelain Co., 36 pp, ill. Catalog of high temperature porcelain products with physical, mechanical and electrical properties. (171)

Plastic Molding. P. R. Mallory Plastics, Inc., 4 pp, ill. Complete production facilities for large scale production of custom-molded parts from design to finishing and assembly. (172)

Carbon Products. Morganite, Inc., 8 pp, ill, No. 1f. Specifications of various carbon bearings and bushings. Properties of six series of Morganite carbon products. (173)

Glass Bonded Mica. Mycalex Corp. of America, 24 pp, ill. Design information for parts to be machined from glass bonded mica. (174)

Plastic Resins and Compounds. Naugatuck Chemical Div., 8 pp, ill. Vinyl, polyester and elastomeric resins and compounds, applications, properties and processing. (175)

Electrochemically Refined Materials. Norton Co. Lists complete line of electrochemically refined refractory materials for industry. (176)

Laminated Resinous Plastics. Panelyte Div., St. Regis Sales Corp., 19 pp, ill. Physical properties, industrial and chemical applications and fabrication of laminated thermosetting resinous plastic. (177)

Precision Molded Thermoplastics. Plastic Molded Parts, Inc., 6 pp. Facilities available for Zytel and other thermoplastic precision moldings. (179)

Industrial Tape. Polyken Products, Div. of Kendall Co., 13 pp. Pressure sensitive tape dictionary. Tapes of all manufacturers described and listed by number. (180)

Nylon Tubing. Polymer Corp., 6 pp, illus. Describes 1000- and 2500-psi pressure tubing that is corrosion resistant and has wide temperature range. (181)

Corrosion Resistant Gasketing. Products Research Co., 5 pp, ill. Features, advantages and specifications of Chromelock corrosion resistant gasketing material. (182)

Polyester Resins. Reichhold Chemicals, Inc. Brochure includes 11 technical bulletins of 2 to 6 pages each describing the Polylite line of liquid thermosetting polyester resins. The bulletins cover molding characteristics and physical properties of 10 resins of various heat and light resistant grades, suitable for use in glass fiber reinforced applications. (183)

Gasket Sheeting. Rogers Corp., 4 pp, ill. Describes a line of asbestos-elastomer material. (184)

Rubber Parts. Stalwart Rubber Co., 16 pp, ill, No. 51SR-1. Describes applications and fabrication of rubber compounds, designed to resist temperature, abrasion, chemicals and weathering. (185)

Carbon Graphite. U. S. Graphite Co., 4 pp, ill. Describes Graphitar, carbon-graphite nonmetallic that is chemically resistant, self-lubricating, hard, light and won't warp. (186)

Plastisol. United Chromium Inc., 4 pp, ill. Physical, chemical properties of Unichrome plastisol compounds used for coating, casting or molding. (187)

Felt. Western Felt Works, 32 pp, ill. History of manufacture and uses of felt, including brief description of present-day methods and applications. (188)

Laminated Plastics. Westinghouse Electric Corp., 50 pp. Catalog on industrial Micarta covering all grades and forms in which Micarta is supplied, and the chemical, mechanical and electrical properties of each. Machining data gives fabrication information. (189)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 67 and 68

Finishes • Cleaning and Finishing

Colloidal Dispersions. Acheson Colloids Co., 4 pp, illus, No. 438. Colloidal dispersions for dry-film lubrication. Various combinations of lubricating solids, carriers with specific application in machine lubrication, metal working and foundry operations. (190)

Sodium Nitrite. Allied Chemical & Dye Corp., Solvay Process Div., No. SP-23A. Describes uses of sodium nitrite for protecting metal surfaces against rust or corrosion. (191)

Zinc, Cadmium Finishes. Allied Research Products Inc. Describes Iridite, finishes for zinc and cadmium in chromium-like, olive green, iridescent and other colors. (192)

Spray Painting. Conforming Matrix Corp., 5 pp, ill. Gives description, uses, and advantages of this firm's spraying masks, mask washing machine, and spray painting equipment. (193)

High Vacuum Equipment. Consolidated Vacuum Corp. Price list of high vacuum equipment and accessories. (194)

Wet-Blasting. The Cro-Plate Co., Inc., 8 pp, ill. Equipment for two-speed wet-blasting for finishing metal parts. (195)

Black Oxide Finish. Du-Lite Chemical Corp. Information on Du-Lite finishes for any steel blackening problem. Also gives information on Du-Lite cleaner, strippers, burnishing compounds, etc. (196)

Wear Resistant Coating. Electrolyzing Corp., 16 pp. Detailed data on the Electrolyzing Process for increasing the life and efficiency of metal parts subjected to wear, abrasion and corrosion. (197)

Spray Painting Equipment. Finish Engineering Co., Inc., 16 pp, illus. Describes pressure formed spray painting masks and auxiliary equipment. Price list included. (198)

Protective Coatings. Industrial Metal Protectives, Inc., 8 pp, ill, No. Z-853. Zincilate self-protecting anti-corrosion coatings for metal parts and products. (200)

Hard-Facing. Mir-O-Col Alloy Co., 72 pp. How to apply hard-facing wherever impact and abrasive conditions

exist. Application index and technical data included. (201)

Aluminum-Chromium Paint. Monroe Co., Inc., 4 pp, ill, No. C54-8. Includes detailed application data on Monco-Alochrom, an aluminum-chromium paint for exterior and interior surfaces of all kinds. (202)

Metal Cleaner. Niagara Alkali Co. Pamphlet gives properties of Nialk Trichlorethylene, high quality metal-cleaning and degreasing agent. (203)

Tar-Base Protective Coatings. Pittsburgh Coke & Chemical Co., Protective Coatings Div. Five bulletins give detailed information concerning Pitt Chem 100 Series of tar-base protective coatings. (204)

Paint Spray. Ransburg Electrocoating Corp., 16 pp, ill. Description of electrostatic spray paint process for automatic industrial applications. (205)

Corrosion Resistant Coating. Specialty Coatings Inc., Div. of Thompson & Co., 6 pp, ill. Examples of how Vinsynite Pretreatment was used in finishing six different types of metal products for good paint adhesion and corrosion resistance. (206)

Chemical Porcelain. U.S. Stoneware Co., 8 pp, ill, No. CP-50. Describes line of chemical porcelain pipe, fittings, valves expansion joints, packing, etc. (207)

Heat Treating • Heating

Heat Treating Ovens. Carl-Mayer Corp., 6 pp, illus, No. HT-53. Brief description of various types of heat treating furnaces and ovens. (208)

Heat Treating Furnaces. The Electric Furnace Co., 4 pp, ill. Shows various gas, oil and electric furnaces for annealing and heat treating requirements and lists applications. (209)

Heat Treat Pots. Electro-Alloys Div., American Brake Shoe Co., 6 pp, ill. Diagrams and chart of types of pots needed for specific heat treatment requirements. (210)

Reducing Atmosphere Generators. Gas Atmospheres, Inc., 4 pp, ill, No. R-352. Atmosphere generators for industrial applications such as bright hardening, annealing, gas carburizing and sintering. (211)

Furnaces. C. I. Hayes Inc., 44 pp, ill, No. 112. Complete data on a variety of furnaces for hardening, tempering, carbonitriding, forge heating, sintering, annealing and tool heat treating, as well as on atmosphere generators and ammonia dissociators. (212)

Atmosphere Control for Heat Treating. Leeds & Northrup Co., 20 pp, illus, No. TD4-620(1). How to control surface carbon content automatically in heat-treating steel. (213)

Tubular Furnaces. Marshall Products Co., 4 pp, ill. Discusses both the creep test and tensile test models of Marshall tubular furnaces, as well as control panels and radial brackets. Includes specifications. (214)

High Frequency Heating. New Rochelle Tool Corp., 16 pp, ill. Describes the principles of induction and dielectric heating. Includes typical specific applications of high frequency heating in welding, brazing and heat treating. (215)

Induction Heating. The Ohio Crankshaft Co. Describes plant survey and possible applications to which induction heating might be put for greater production economy. (216)

Appliance Insulation. Owens-Corning Fiberglas Corp., 8 pp, ill. Analysis of various products utilizing Fiberglas for temperature or sound insulation. (217)

Electric Furnaces. Pereny Equipment Co., 3 pp, ill, No. 4A. Booklet tells advantages and illustrates typical group of furnaces and kilns and their uses. (218)

Cold Treatment Equipment. Revco Inc., 2 pp, ill. Describes cold treating cabinets for seasoning gages and precision tools, for testing, for shrink fits, and for aircraft rivet applications. (219)

Temperature-Sensitive Crayons. Tempil Corp. Revised instructions for using "Tempilsticks," with a chart of temperature ratings available. (220)

Welding • Joining

Spot Welding. Air Reduction Co., 4 pp, ill. Describes inert gas shielded spot welding gun requiring no back-up plate for stainless and mild steels. (221)

Brazing Alloys. The American Platinum Works, 46 pp, ill. Handy-sized manual gives detailed description of the brazing process, the alloys used, design of joints and other considerations for successful joining. (222)

Explosive Rivets. E. I. du Pont de Nemours & Co. (Inc.), Explosive Dept., 39 pp, ill, No. A-2785. Gives sizes, installation and variety of uses of du Pont's explosive rivets. (223)

Fasteners. H. M. Harper Co., 8 pp, ill, Vol. 19, No. 2. Various case histories of the applications of Harper's fasteners, emphasizing corrosion-resistant bolts. (224)

Electrodes and Holders. P. R. Mallory & Co., Inc., Welding Div., 2 pp, ill, No. 8-11. Advantages, design and application of 8-deg (4 deg per side) ⅝-dia spot welding electrodes and holders. (225)

Precious Metal Solder. The J. M. Ney Co., 1 p. Melting ranges, colors and identification numbers of this company's gold and platinum solders for electronic tubes. (226)

Self-Locking Set Screws. Set Screw & Mfg. Co., 20 pp, ill. Illustrates and describes various types of standard and self-locking set screws with data on dimensions, prices, heads, points and materials. (227)

Cold Formed Fasteners. Townsend Co., 4 pp, ill, No. TL89. Discusses features, advantages and design requirements for fabricating cold headed parts and fasteners. (228)

Forming • Casting • Molding • Machining

Flame Hardening. The Cincinnati Milling Machine Co., 20 pp, ill, No. M-1624. Electronic control flame hardening machine for hardening parts in production quantities to conform to metallurgical standards previously impractical. (229)

Moly-Sulfide Lubricant. Climax Molybdenum Co., 40 pp. Detailed tables of applications of moly-sulfide lubricant in the manufacturing plant, the job shop and the field, indicating form used, and results of application. (230)

Steel Fabrication. Gussett Boiler & Welding, Inc., 8 pp, ill. Describes facilities for steel and alloy plate fabrication of vessels, tanks, hoppers, stacks, machine bases and other weldments. (231)

Tablet Presses. Kux Machine Co., 4 pp, ill. Tableting presses for production of powdered metal parts, ceramic parts, explosives, etc. (232)

Die Casting Machines. Lester-Phoenix, Inc. Folder gives description, features and specifications of this company's die casting machines and injection molding machines. (233)

Cold Extrusion. Mullins Mfg. Corp., Koldflo Div., 16 pp, ill. How low carbon steel parts are cold extruded and fabricated in one piece without machining. (234)

Tungsten Carbide Compacting Tools. National Carbide Die Co., 4 pp, ill. Discusses various tungsten carbide compacting tools as they are applied to powdered metallurgy. (235)

Tube Mills. The Yoder Co., 65 pp, ill. Pros and cons of operating a tube mill, plus detailed information on the process. Also technical data on standard and other equipment. (236)

Inspection • Testing • Control

Industrial Radiography. Atomic Energy of Canada Ltd., Commercial Products Div. Up-to-date information on nondestructive testing of metals by gamma radiography. (247)

Surface Roughness Scale. Gar Precision Parts, Inc., 4 pp, ill. Low cost Microfinish Comparator made by electroforming for use in inspection, quality control, etc. (237)

Radiography. General Electric Co., X-Ray Dept. A new house organ, "Radiation Digest," devoted to industrial x-ray applications and commercial irradiation techniques. Contains news of the field and feature articles. Published quarterly. (238)

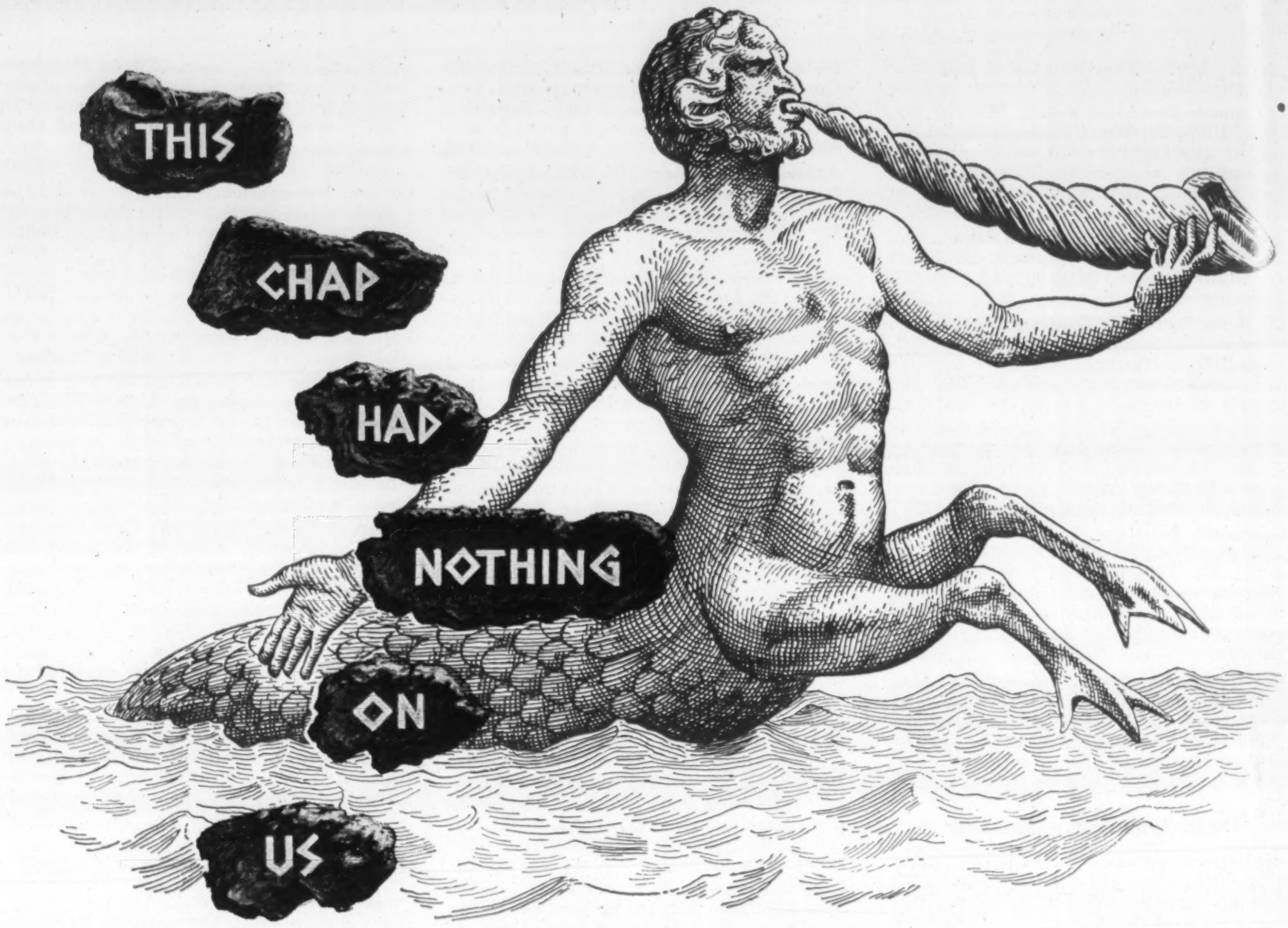
Furnace Temperature Indicator. Claud S. Gordon Co., 2 pp, ill. Describes device which quickly indicates any deviation from desired furnace temperature. (239)

Pyrometers. Illinois Testing Labs Inc., 6 pp, ill. Thermoelectric pyrometer for precision measurements of temperatures beyond 1000 F. (240)

Hardness Testers. Riehle Testing Machines, Div. of American Machine & Metals, Inc., 4 pp, ill, No. RH-1154. Portable hardness testers for Rockwell readings with scales A, B, C, D, F and G. (241)

Tensile Testing Machines. Scott Testers, Inc., 6 pp, ill, No. 50. Shows wide assortment of testing machines for testing tensile strength of materials such as rubber, paper, wire and thread. (242)

Hardness Testers. Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc. Engineering data, uses and design features of Rockwell hardness testers. (243)



He's Proteus, Neptune's son, a highly versatile character—hence the adjective *protean.* You never knew whether next you'd see him as a lion, a raging fire, a reptile, or an angry bull.

Here at Driver-Harris, we do protean marvels too . . . with *metals.* For instance, Nichrome*, the unique heat-resistant, corrosion-resistant, electrical-resistance alloy known the world over, has long been the engineer's yardstick of comparison not in one, but *in at least 3 widely different applications.*

TO GENERATE HEAT: In all applications of producing heat by electricity, particularly to temperatures above 1700°F., Nichrome and Nichrome V set the quality standard. From simple electrical appliances such as ranges, broilers, toasters, etc. to giant industrial furnaces, no other alloys enjoy such widespread recognition and use.

TO RESIST HEAT: Because of its unsurpassed resistance to heat and corrosion, Nichrome is used for making massive furnace muffles and retorts often weighing tons, and work-loading fixtures of all shapes. The outstanding property of Nichrome here is its extremely long life, which results in low heat-hour costs.

TO RESIST ELECTRICITY: The greatest contribution to outstanding stability and miniaturization of resistors is made by Nichrome wire. Drawn to sizes as small as .0005 and finished in a variety of insulations, Nichrome is a boon to electronics in the manufacture of high tolerance resistance units of all types.

Added to the nickel and chrome of Nichrome and Nichrome V is always one exclusive ingredient—the supreme mastery of the Driver-Harris specialists, gained in their 57 years of melting and drawing experience.

In recognition of its unique properties, the United States Patent Office in August, 1908, granted solely and exclusively to us the trademark NICHROME. There is *only* one Nichrome, and it is made only by Driver-Harris.

*T. M. Reg. U. S. Pat. Off.

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BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco

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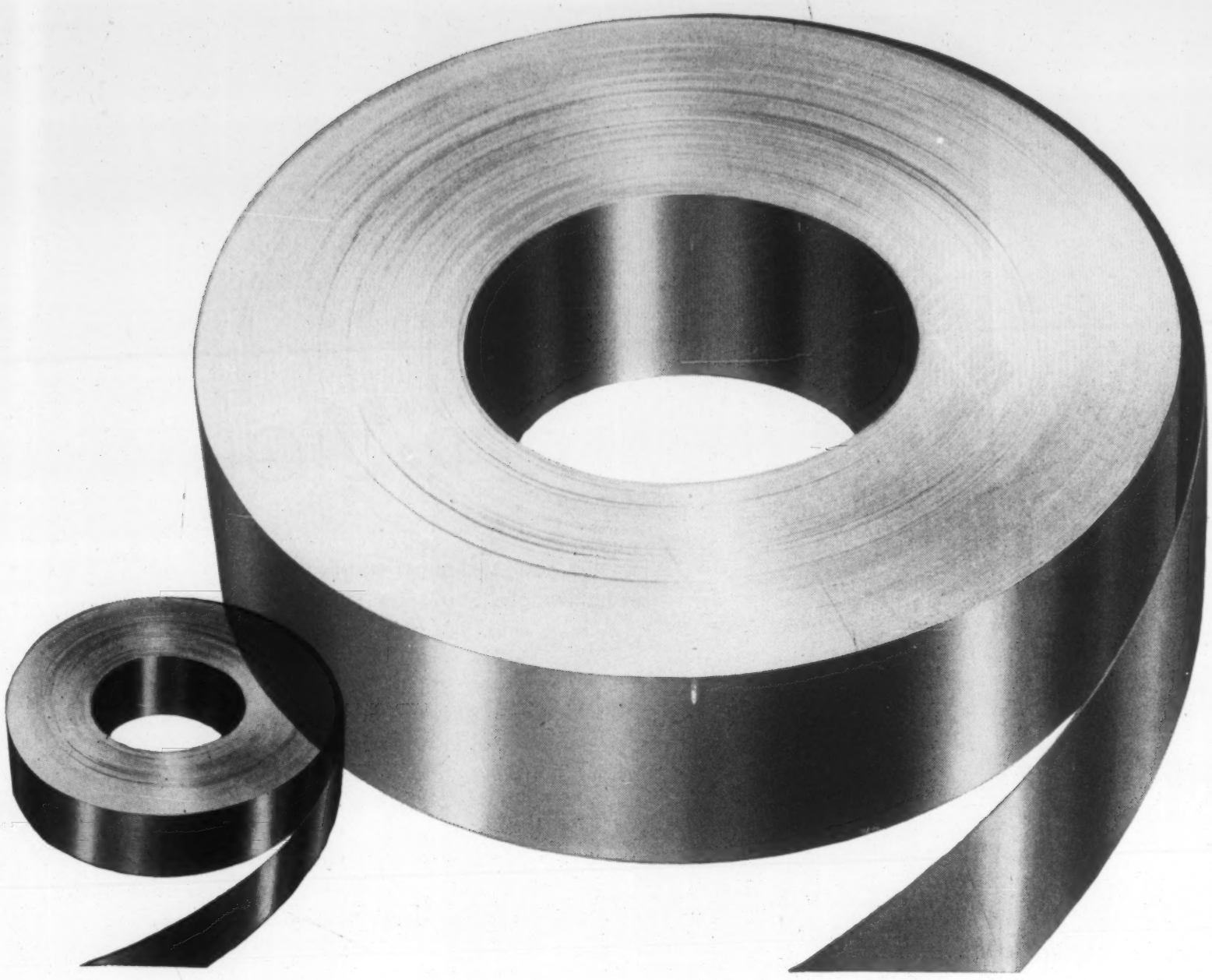

Brainard triples electro-galvanized steel capacity to give you faster service

● A new Brainard plant triples capacity for electro-galvanized steel . . . assures you fast service on standard or special orders. Brainard's fully integrated operation, from ore to finished products, gives you a dependable source of supply at all times.

Brainard electro-galvanized steel has a built-in finish . . . plating and finishing costs are eliminated. Coating provides permanent protection against rust and corrosion. Coating thickness can be supplied as specified.

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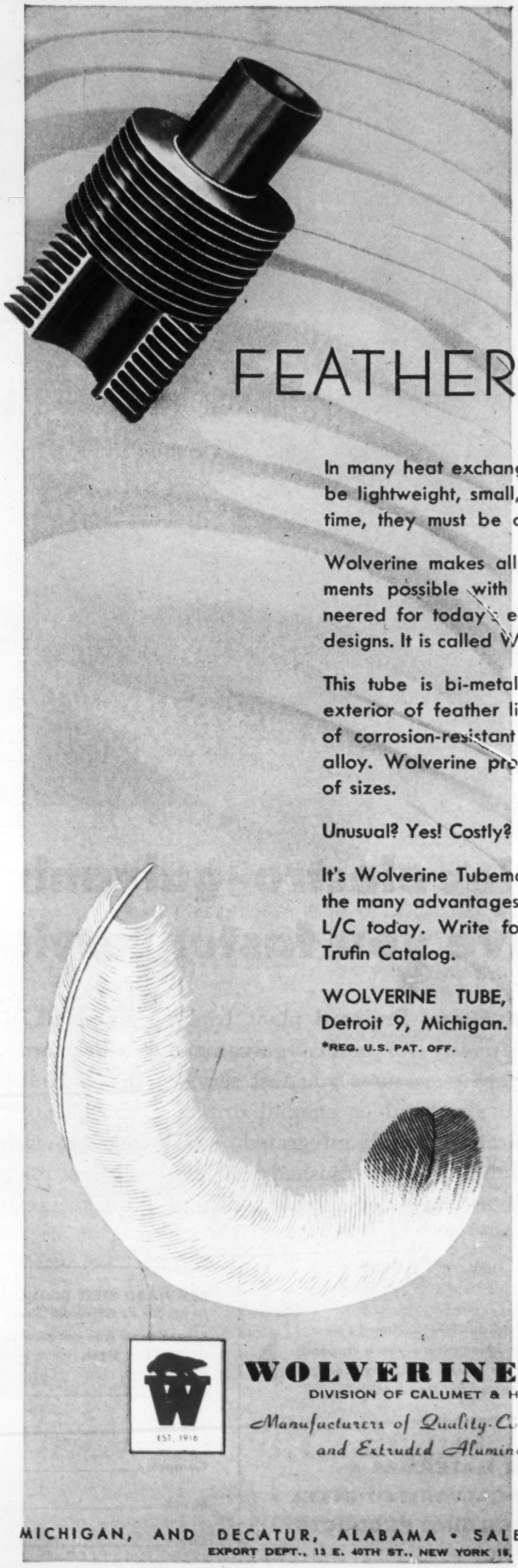

FEATHER LIGHT

In many heat exchanger applications, units must be lightweight, small, low in cost. At the same time, they must be dependable and efficient.

Wolverine makes all of these unique requirements possible with a tube specifically engineered for today's economy-minded condenser designs. It is called Wolverine Trufin* Type L/C.

This tube is bi-metal with an integral finned exterior of feather light aluminum and a liner of corrosion-resistant copper or copper base alloy. Wolverine produces it in a wide range of sizes.

Unusual? Yes! Costly? No!

It's Wolverine Tubemanship at work! Look into the many advantages of Wolverine Trufin Type L/C today. Write for a copy of Wolverine's Trufin Catalog.

WOLVERINE TUBE, 1439 Central Avenue, Detroit 9, Michigan.

*REG. U.S. PAT. OFF.

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DIVISION OF CALUMET & HECLA, INC.

Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.

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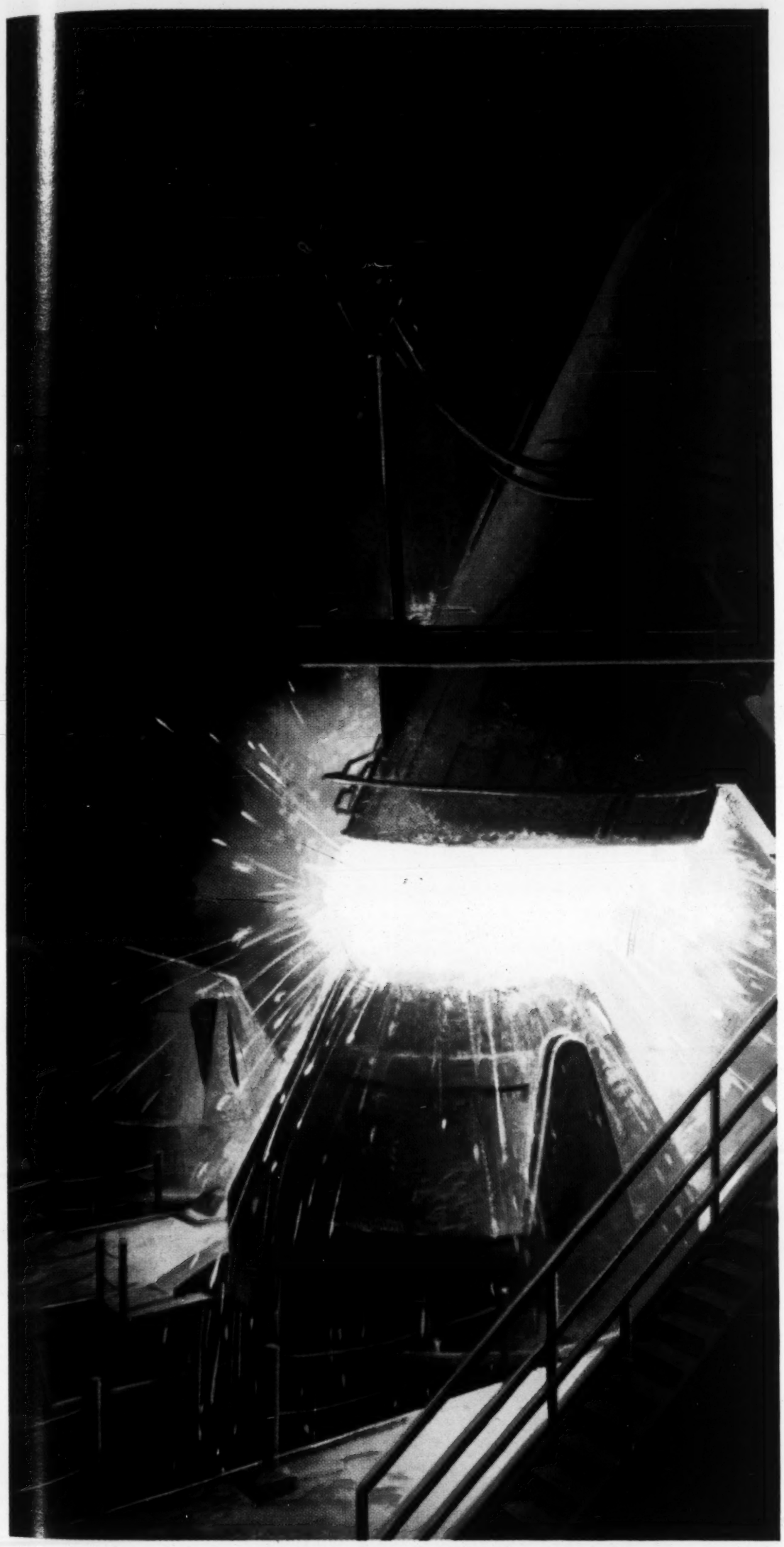
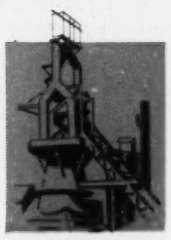
For more information, Circle No. 485 ➤



McLouth
HIGH QUALITY
Steel

We are now operating the first Oxygen Steel Process in the United States. This dramatic new method of refining is producing high quality steel with a low nitrogen content.

The advantages of the Oxygen Steel Process are another reason why McLouth high quality sheet and strip steels will serve you better in the product you make today and the product you plan for tomorrow.



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Detroit, Michigan

MANUFACTURERS OF STAINLESS AND CARBON STEELS

Coating tower, 41 feet high, built and insulated with Johns-Manville Marinite

"Production speeded...quality control improved"

with coating towers built of Marinite, the non-corroding, structural insulating material

When Electro Technical Products, a division of Sun Chemical Corp., built new coating towers with Johns-Manville Marinite*, they stepped up performance and reduced maintenance of their drying equipment.

The Company found: (1) Marinite speeds production because it provides more uniform heat. (2) Marinite improves quality control because temperatures can be maintained more accurately. (3) Marinite virtually eliminates maintenance because it does not rot or corrode.

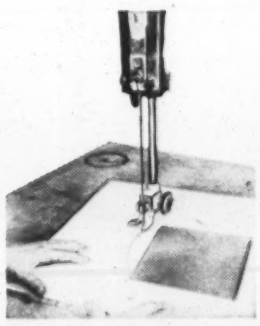
J-M Marinite is an asbestos material which combines structural strength with efficient thermal insulation. It offers many advantages for driers, ovens and other high temperature equipment.

Marinite simplifies construction because it builds and insulates in one operation. Marinite speeds production because it provides uniform heat and better heat control. Marinite reduces maintenance because it has almost unlimited service life. It does not rot or corrode . . . it does not disintegrate in water . . . it needs no protective facing for normal use. To learn how Marinite can improve your equipment, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

*Marinite is a registered Johns-Manville trade mark.

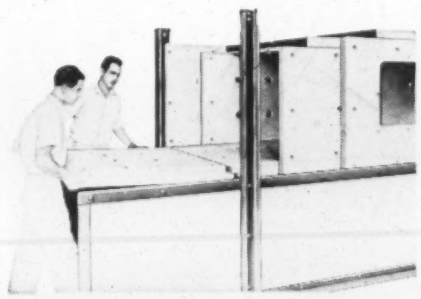
MARINITE builds and insulates in one operation

large, structurally strong sheets afford maximum heat control



MARINITE is easily worked

may be cut, drilled, shaped and fitted with ordinary woodworking tools



MARINITE speeds construction

can be erected without costly equipment—requires minimum angle-iron framing

Johns-Manville *FIRST IN* INSULATION

MATERIALS • ENGINEERING • APPLICATION

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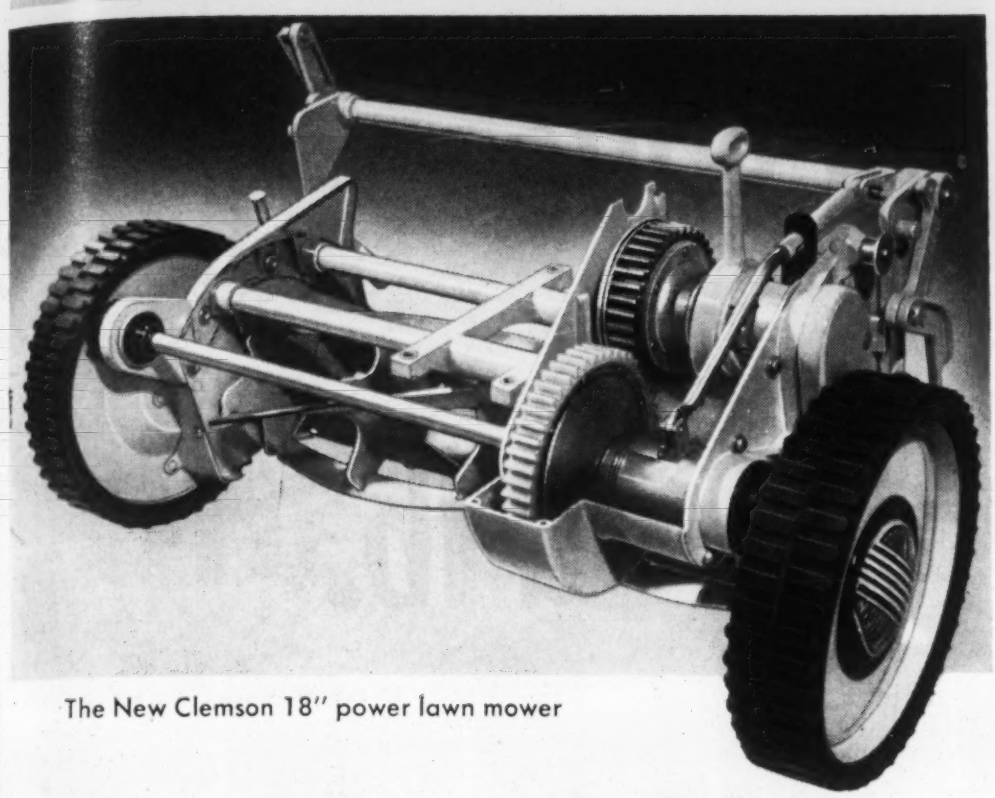
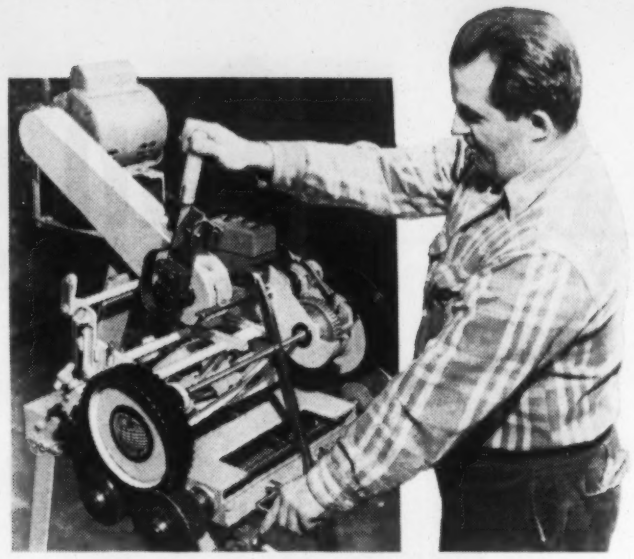
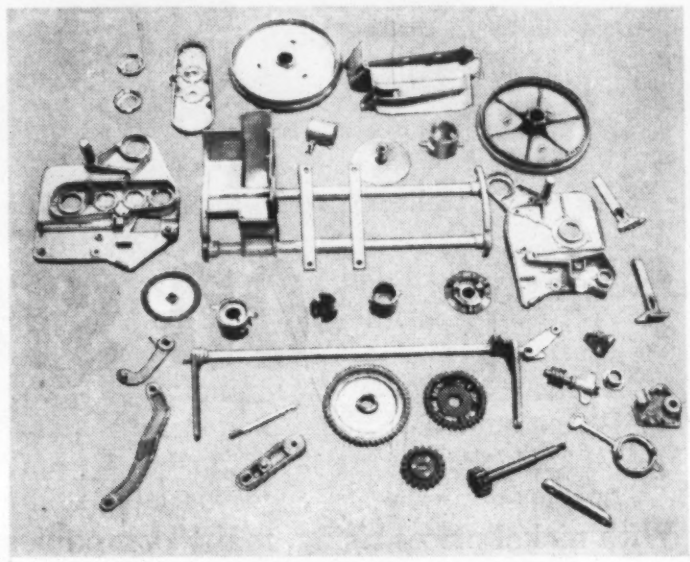
DIE CASTING REPORT



The New Clemson 18" power lawn mower



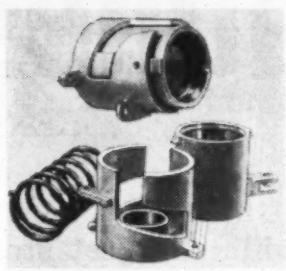
Testing die-cast clutches and cams



34 die-cast parts from 27 dies

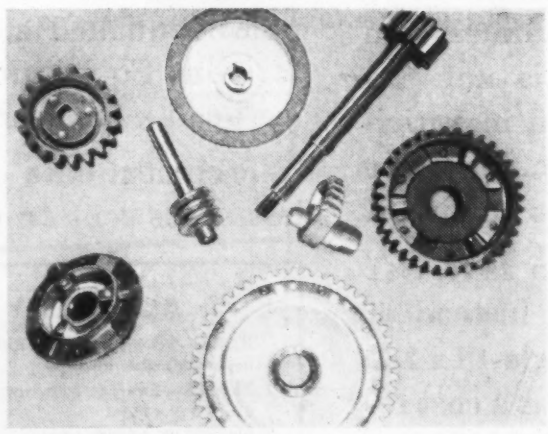
New Lightweight Power Lawn Mower---

Utilizes 34 die-castings to cut production costs, assembly time and integrate parts

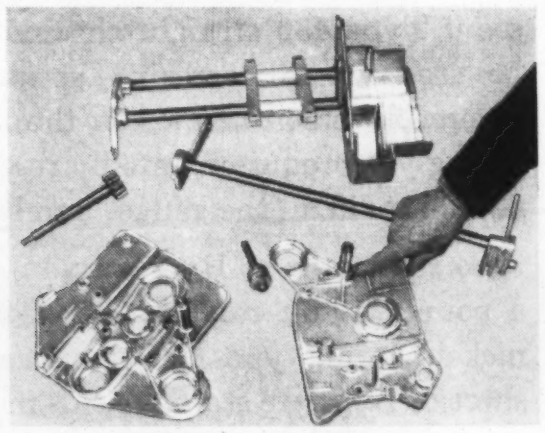


Die-cast gears, worms

No stranger to die-castings (having specified them successfully since the earliest 1937 model), Clemson Bros., of Middletown, N. Y., a leading lawn mower manufacturer, decided to go all out on their new power unit. Reason: Clemson found die-castings cut costs and could withstand functional shock, stress and strain. In addition, engineers had increased freedom in designing a more efficient, sales-appealing machine. Working closely with Precision die builders, they made maximum use of modern die-casting techniques to produce complicated steel inserts, worms, sleeves, gears, cam surfaces and achieve unusual contours. Majority of machining done by the die-caster simplified assembly of component parts, many of which were held to such close tolerances they could be used "as cast."



Die-cast steel inserts



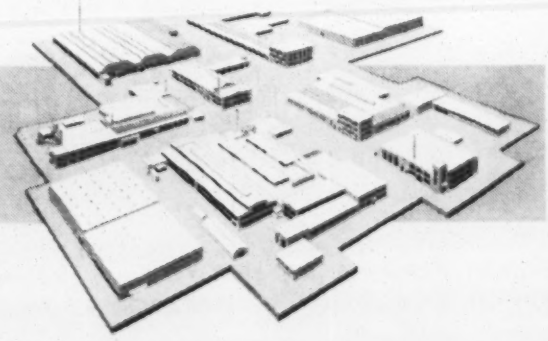
Cam surfaces cast in shells

Extensive Use of Functional Die-Castings Pays Dividends

If you are planning to design functional parts, why not look into the advantages of aluminum, magnesium or zinc die-castings. Precision's team of creative engineers will be glad to show you how this modern production process can help cut costs and supply unlimited number of identical parts, held to close tolerances. Write on your letterhead for a copy of "Die-Castings...Unlimited." Address: Precision Castings Co., Inc., 311 Walnut St., Fayetteville, N. Y.

PRECISION CASTINGS CO., INC.

World's largest independent producer: aluminum, magnesium and zinc die castings



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Can you save

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on stainless?

With nickel prices rising, many companies will be re-examining their stainless applications to see if Type 430 straight-chrome stainless can be used where corrosive action is not too severe. Ryerson has taken the lead in anticipating your requirements by re-stocking Type 430 sheets in all the gauges and sizes you need.

So right now at Ryerson you can save 7¼¢ a pound if you can use Type 430 instead of nickel-bearing types. Even on a single 48 x 120 sheet of 16-gauge stainless this means a cost reduction of $7.47 with Type 430, plus additional savings because of lower weight. And you may also want to consider Type 430 as insurance against any shortage of nickel-bearing types.

You'll save time, in any case, by calling Ryerson because here you draw on the nation's largest stocks of both straight-chrome and nickel-bearing Allegheny stainless and here you put unequalled stainless experience to work for you. So for quick, complete stainless service—call your nearby Ryerson plant.

Technical data on Type 430 or other stainless steels sent on request.

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One point of view

Keeping track of technical information

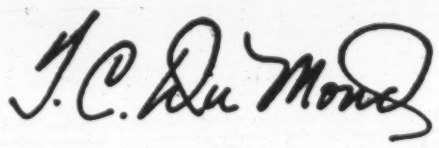
Recently, in a speech before the American Society of Mechanical Engineers, Dr. Vannevar Bush revealed some interesting observations on some of the problems of technical information. It is Dr. Bush's feeling that technical information is being developed at such a rapid pace that those who would use information are being hard pressed to devise methods of storing and recalling data which might be useful to them.

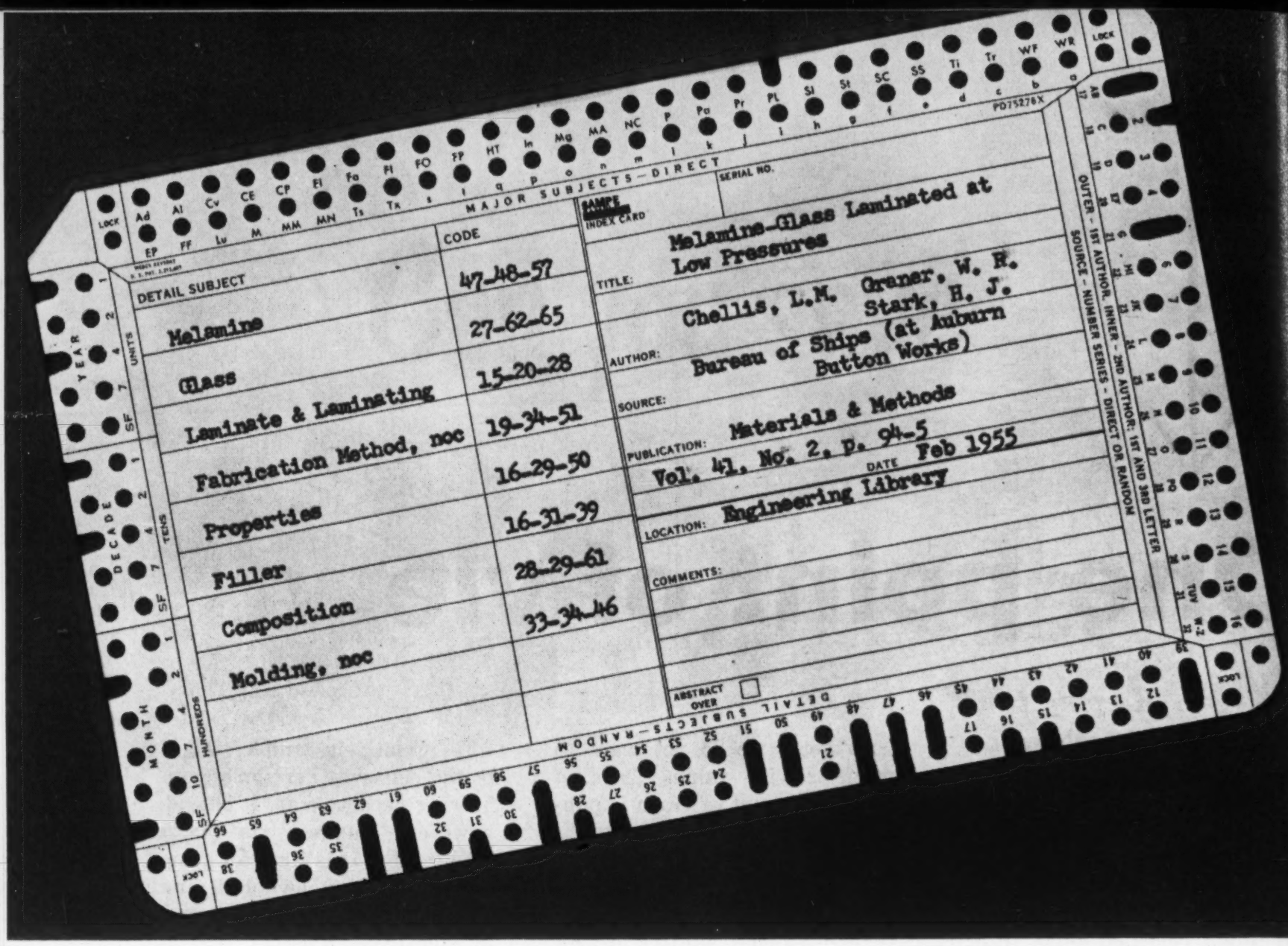
We agree that the problem is growing in intensity. We feel a similar need in our own operations and have heard other expressions of concern in many of our plant visits. In thinking of the mountains of technical information developed each year, we do not want to minimize its value. True, a certain amount of trash is published, but most of the material made available is worth retaining.

Our thoughts have been returned to the subject by an article on the following pages. The article resulted from a visit to Northrop Aircraft, Inc., where we discovered various engineers using the system described with a high degree of success. Although suggestions of other data classifying systems are included, the plan developed by the Society of Aircraft Materials and Process Engineers is particularly useful for the indexing of published data on engineering materials, parts, finishes and the various processes used with them.

The system we describe, while relatively simple, might be too elaborate for some engineering departments. It should, however, suggest to most readers that it is time for them to review their own indexing systems. At the other extreme, it might be possible that a highly complex machine tabulating system be adopted to assure you of having instantly available all sources of information.

Essentially what we all should be on guard against is to permit valuable information to be lost in limbo just because we didn't take the time to keep it within reach. All the information and knowledge in the world is useless unless we can put our hands on it.





This punched card is the basis of a

New Index for Materials and Processes

Though developed for the aircraft industry, its main features can be applied to any manufacturing industry.

■ As the volume of technical literature continues to grow, it has become more and more difficult to isolate information available on a specific subject. The result has been the development of several new systems for indexing literature in specific fields. One of the most recent and modern is the SAMPE Indexing System described in this article.

The SAMPE system uses marginal hand-punched cards. Although only one card is prepared for each article or report indexed, the system makes it possible to locate specific information in many different ways—usually by major subjects, detail subjects, authors, source or date.

The new indexing system was developed by the Society of Aircraft Material and Process Engineers, and has been endorsed by

New indexing system *is checked by Jack Grace (left) of North American Aviation and Charles Miller of Northrop Aircraft. Grace was chairman of the SAMPE committee that developed the system.*

Major Subjects

Ad	Adhesives
Al	Aluminum
CP	Cleaning and Polishing
Cu	Copper
CE	Corrosion and Erosion
El	Elastomers
Fa	Fabrication Methods
FF	Functional Fluids (energy transmitting)
FI	Finishes, Inorganic
FO	Finishes, Organic
FP	Fuels and Propellants
HT	Heat Treatment
In	Insulation (acoustic, electric, thermal)
Lu	Lubricants
Mg	Magnesium
MA	Mechanical Attachments
NC	Nickel or Cobalt
Pa	Packaging
P	Plastics, miscellaneous
PL	Plastics, Laminated
Pr	Processes, miscellaneous
SC	Sandwich Construction
SI	Seals and Sealants
St	Steel
SS	Steel (300, 400, and 500 Types)
Ts	Testing
Tx	Textiles
Ti	Titanium
Tr	Transparent Materials
WF	Welding, Fusion (including brazing and soldering)
WR	Welding, Resistance (including pressure welding)
M	Miscellaneous (not otherwise classified)
MM	Miscellaneous Metallic Materials
MN	Miscellaneous Non-Metallic Materials
EP	Equipment and Parts

the Aircraft Research and Testing Committee of the Aircraft Industries Association of America, Inc. It consists of a design for a hand-punched card (the card itself is available from the McBee Co.), a coding system for indexing subject matter in the broad field of aircraft materials and processes, and a basic subject index which can be greatly expanded to meet the requirements of individual users. Modern techniques of random number coding and coordinated word or idea indexing are incorporated in system.

The indexing system has been in use in materials and processes engineering groups of several airframe manufacturers for more than a year and has been reported generally satisfactory. Although the SAMPE system was developed specifically for the aircraft materials and processes field, a similar system could be readily developed for any manufacturing field.

Major subject index

The subject index has two parts: a "major subject index" and a "detail subject index".

A direct major subject index was provided to simplify the process of searching and to provide a means of segregation if it is necessary to keep the cards in separate drawers. The number of cards that must be handled in sorting for detail subjects can be greatly reduced by first sorting for major subjects. Major subject sorting also reduces to a minimum the number of unwanted cards obtained in detail subject sorting.

The 35 major subjects selected are listed elsewhere in this article. They cover the principal fields of interest in aircraft materials and processes and are substantially mutually exclusive. Subject divisions were made on the basis of approximately equal volume of use in a typical aircraft materials and processes file.

The major subjects are represented on the card by holes at the top and are identified by symbols. The symbols are arranged in approximate alphabetical order, except that infrequently used subjects are placed on the inner row of holes to minimize the need for "O-slot" sorting. The major subject index allows for more than 50% expansion in major subjects. The remaining 19 holes available for additional major subjects are labeled with lower case letters for identification.

Unlimited cross-referencing of major subjects is permissible, but only those major subjects directly applicable to the information being indexed should be punched to avoid sorting cards only remotely related to the desired subject. Under the SAMPE system, the indexer is instructed to approach information to be indexed from the standpoint first of the material, then processing, then equipment. For example, an article on automatic arc welding of steel would be indexed by punching first *St* (steel), then *WF* (welding, fusion), and finally (if the article deals sufficiently with the equipment involved) *EP* (equipment and parts).

Detail subject index

The detail subject index contains approximately 900 different subjects. These subjects comprise a coordinated word or idea index and are generally basic nouns of aircraft materials and processes terminology. They are listed alphabetically and have no other order, preference or priority. For convenience, subjects containing more than one word are generally listed in each appropriate alphabetical position so they can be located by any significant word. In many cases, words of very similar meaning have been combined into a single subject to avoid confusion.

On the card, the detail subjects are coded by a combination of numbers represented by holes at the bottom of the card. The 56 holes are labeled with successive numbers from 11 to 66 in order to standardize on two-digit numbers. The code for each detail subject consists of three of these two-digit numbers arranged in order of increasing magnitude. In other words, three holes must be punched for each detail subject to be indexed. Altogether, there are 27,720 possible combinations of 56 two-digit numbers so arranged. Hence, the detail subject index allows for a 30-fold expansion in detail subjects.

When several detail subjects are punched on the same card the possibility arises that each of the three numbers punched for one subject may also be punched as part of the code for another subject. For example, an article on the electroforming of cobalt alloys would be indexed by punching 20-34-42 (electroforming) and 12-40-51 (cobalt and cobalt alloys not otherwise classified). A direct detail subject sorting out of cards pertaining to magnesium alloy AZ80X (20-34-51) would result also in the sorting out of any cards pertaining to electroforming of cobalt alloys.

In actual practice, the number of unwanted cards sorted out is normally quite small. There are several reasons:

First, the code numbers were selected randomly in order to minimize the coincidence of combinations. The method of random selection is described elsewhere in this article.

Second, the sorting out of unwanted cards is reduced considerably by a preliminary sorting out by major subject. In the example cited above, the unwanted cards on electroforming of cobalt alloys

Page 48

DETAIL SUBJECT INDEX

47-48-57	Melamine
16-33-36	Mercury
19-60-61	Metal Arc, Inert Gas (Sigma) Welding
46-49-51	Metal Clad
22-35-36	Metal Dip Coating
12-28-50	Metallic Arc Welding
19-32-48	Metallographic Testing
13-36-50	Metal Spray Coating
11-25-43	Meter
11-25-36	Methacrylate (see Acrylic)
19-34-51	Method Fabrication noc
43-50-52	Methods, Material Manufacturing
27-47-51	Methods, Statistical and Sampling
33-55-60	Methyl Alcohol
16-28-30	Mica
28-37-55	Micro-organism
17-33-65	Microstructure
28-37-55	Mildew (see Micro-organism)
14-17-52	Military, Federal, Government, A.N.

Random Codes

The code numbers used in detail subject indexing were selected randomly. The method was as follows:

The source of random numbers used was a table of Random Digits published by Rand Corp. This table consists of 50,000 digits, 0 through 9. Two digits were selected in order from a pair of columns. Numbers below 11, e.g., 10, 09, 08, etc., and above 66 were discarded (without affecting randomness). Each group of three adjacent two-digit numbers was combined and rearranged in order of ascendency, e.g., 42-14-53 was rearranged to 14-42-53.

To prevent selection of the same code for two different subjects, it was necessary to keep a record of the codes developed. Fifty-six sheets of graph paper, numbered from 11 through 66, were numbered along both abscissa and ordinate from 11 through 66. The sheet number represented the smallest, the ordinate number the middle and the abscissa the largest number in the code. Hence, the existence of the code 14-42-53 was noted by cancelling the block at the intersection of "42" on the ordinate and "53" on the abscissa on sheet number "14".

would be eliminated by first sorting out the cards on major subject *Mg* (magnesium).

Third, it has been shown mathematically that a minimum number of unwanted cards is obtained provided the number of code numbers punched in a card is not more than one-half the total number of holes available. Since there are 56 holes available and each detail subject requires three holes, slightly over nine cross references of detail subjects can theoretically be permitted. However, because of the reduction in unwanted cards provided by major subject sorting, the maximum number of detail subject cross references has been set at 10.

Within this limit, the indexer is instructed to code the card with all of the appropriate detail subjects related to the information being indexed. For example, an article on cadmium plating would normally be coded for "electroplating" and "cadmium." Depending upon its content, the same article might also be coded for "hydrogen embrittlement", "surface roughness and inspection", etc. Multi-word subjects may be compounded by coding each segment, e.g., coding "sodium" and "phosphate" for sodium phosphate (each segment counts as a separate cross reference). In general, the indexer's job is to give the searcher as many appropriate means of access to the information as possible.

On a card where more than one detail subject has been coded, it is impossible to tell by looking at the punched holes what subjects have been cross-referenced. The card, therefore, provides 10 spaces in which the indexer lists the detail subjects that have been indexed, together with their code numbers. This list helps the searcher in scanning the cards.

The searcher, after sorting the appropriate major subjects, approaches the specific subject desired by progressive sorting of the applicable detail subjects. Ultimately the sorted cards are reduced to a number that can conveniently be examined individually. An individual card may often be obtained by progressive needle sorting. However, the goal of the SAMPE indexing system is to ensure that all available information is accessible to the searcher, not necessarily that an individual card be readily sorted.

A new major or detail subject may be added to the index at any time. A code number is assigned from the list of available codes, and all copies of the index are altered to indicate the new assignment and prevent duplicate assignments.

Author index

The *author* and *source* fields are superimposed on the double row of holes along the right hand edge of the card. The *author* field utilizes the alphabetical symbols which apply to both the inner and outer rows. The *source* field utilizes the numerical symbols.

An author's name is indexed by punching two holes, one each for the first and third letters of his last name. For a single author or a senior author, these holes are punched in the outer row. For a second or junior author, if any, the holes are punched in the inner row.

The two-hole scheme not only reduces the number of cards to be handled but also is necessary in order to avoid unwanted cards resulting from use of the superimposed *source* field. Since there are cases where ordinarily only one hole would be punched or the same hole might be punched twice, special rules have been adopted to insure two-hole indexing.

For example, the last lettered hole, *W-Z*, represents not only those letters but also duplication of letters. In "Papas", where the first and third letters of the last name are identical, the *P* hole is punched and the *W-Z* hole is also punched to indicate duplication. In "Bean", where the first and third letters are represented by the same hole, the *B* and *W-Z* holes are punched. If both the first and third letters are represented by the *W-Z* hole, as in "Whyle", both the inner and the outer hole are punched (a deep punch is used).

The following rules were adopted to cover other special cases:

1. Multiple or hyphenated surnames are indexed by punching the first letter of each of the first two sections, e.g., *V* and *D* for Van Dyke, *I* and *K* for Inman-Kane, *S* and *C* for St. Claire, and *M* and *L* for MacLoud. Should a name that is sometimes compounded or hyphenated be written out, it is indexed by punching the first and third letters, e.g., *M* and *C* for Macdonald.

2. A two-letter last name is indexed by punching both letters, e.g., *P* and *O* for Li Po.

Source index

The *source* field consists of 32 holes numbered consecutively from *1* to *32*. Although known as the *source* field, it may actually be used for any other purpose desired. Coding may be direct or random. A direct code, i.e., one producing no unwanted cards as

Other Systems

Several technical societies have developed indexing systems for literature in their own fields of activity. Two widely used systems utilizing marginal hand-punched cards are the ASM-SLA Metallurgical Literature Classification, developed by the the American Society for Metals and the Special Libraries Association; and the NACE Abstract Punch Card Service, developed by the National Association of Corrosion Engineers.

In 1946, the American Chemical Society appointed a Committee on Punched Cards to explore the potentialities of the method. The result was a book "Punched Cards, Their Application to Science and Industry", edited by two members of the ACS committee, R. S. Casey and J. W. Perry, and published by Reinhold Publishing Corp. (New York, N. Y.) in 1951. Many privately-developed punch card indexing systems are described in this book.

a result of superimposition, can be developed by assigning a two-number code to each source or subject: one number in the outer row of holes (*1* through *16*) and the other in the inner row (*17* through *32*). A total of 256 different combinations is possible.

Date Index

The *date* and *number* fields utilize the double row of numbered holes along the left hand edge of the card.

A *date* is indexed by punching the *month, decade* and *year*, e.g., March '53, in the outer row of holes in the three blocks so labeled. Two holes are punched in each block, their sum being the number indexed. Where only one hole is required the *SF* (single figure) hole is punched also. Months are coded by figures representing their numerical order.

For example, "March" is indexed by punching *2* and *1*, January by *1* and *SF*, and October by *10* and *SF*. In some cases, the month could be indicated by two holes in two different ways; by agreement November is represented by *10* and *1*.

The *decade* and *year* blocks are used in a similar manner. For example, "53" is indexed by punching *4* and *1* in the *decade* block, and *2* and *1* in the *year* block. In both of these blocks, the figure "0" is indexed by punching *7* and *4*.

Number field

The *number* field consists of the inner row of holes on the left hand edge of the card. Numbers may be coded by punching two holes each in the *hundreds, tens* and *units* blocks. The *tens* and *units* blocks are used in a manner similar to the *decade* and *year* blocks. Since the *hundreds* block includes the symbol *10*, it can be used to represent consecutive numbers from 1 to 12. Thus, a numerical series of 1299 numbers is possible.

Similarly, a series of 12,999 consecutive numbers can be coded directly on the number field by ignoring the last digit; only 10 cards would require hand sorting. The *hundreds* would represent thousands, the *tens* would represent hundreds, the *units* would represent tens, and the units would be sorted by hand.

A consecutive series of 32,999 numbers can be coded directly by using the 32 holes of the *source* field to represent the thousands or ten thousands.

A consecutive series of 999,999 numbers can be coded directly by using the *number* field for the last three digits and the *date* field for the first three digits. In both the *month* and *hundreds* blocks, the *10* hole should be disregarded and the *7* and *4* holes punched to represent "0". This use of the card eliminates the *date* field, since otherwise too many unwanted cards would drop.

Card entries

The back of the card provides space for an abstract if desired. The front of the card provides a number of blocks in which is entered the information needed to describe the reference. These are:

1. Serial number—for use in a charge-out system or in replacing damaged or lost cards.
2. Title—title of the reference.
3. Author—author(s) of the reference.
4. Source—name of the company, organization or agency under whose auspices the work described in the reference was performed.
5. Publication — information about the book, periodical or report needed to obtain the reference from the publisher, library, company or other organization.
6. Date—date of the publication.
7. Location — physical location of the reference.
8. Comments—brief notes as to the value or scope of the reference, but not an abstract.
9. Abstract over—a means of indicating whether an abstract appears on reverse side of card.
10. Detail subject and code—a list of the detail subjects cross-referenced and their code numbers (see "Detail subject index").

Coding and Sorting

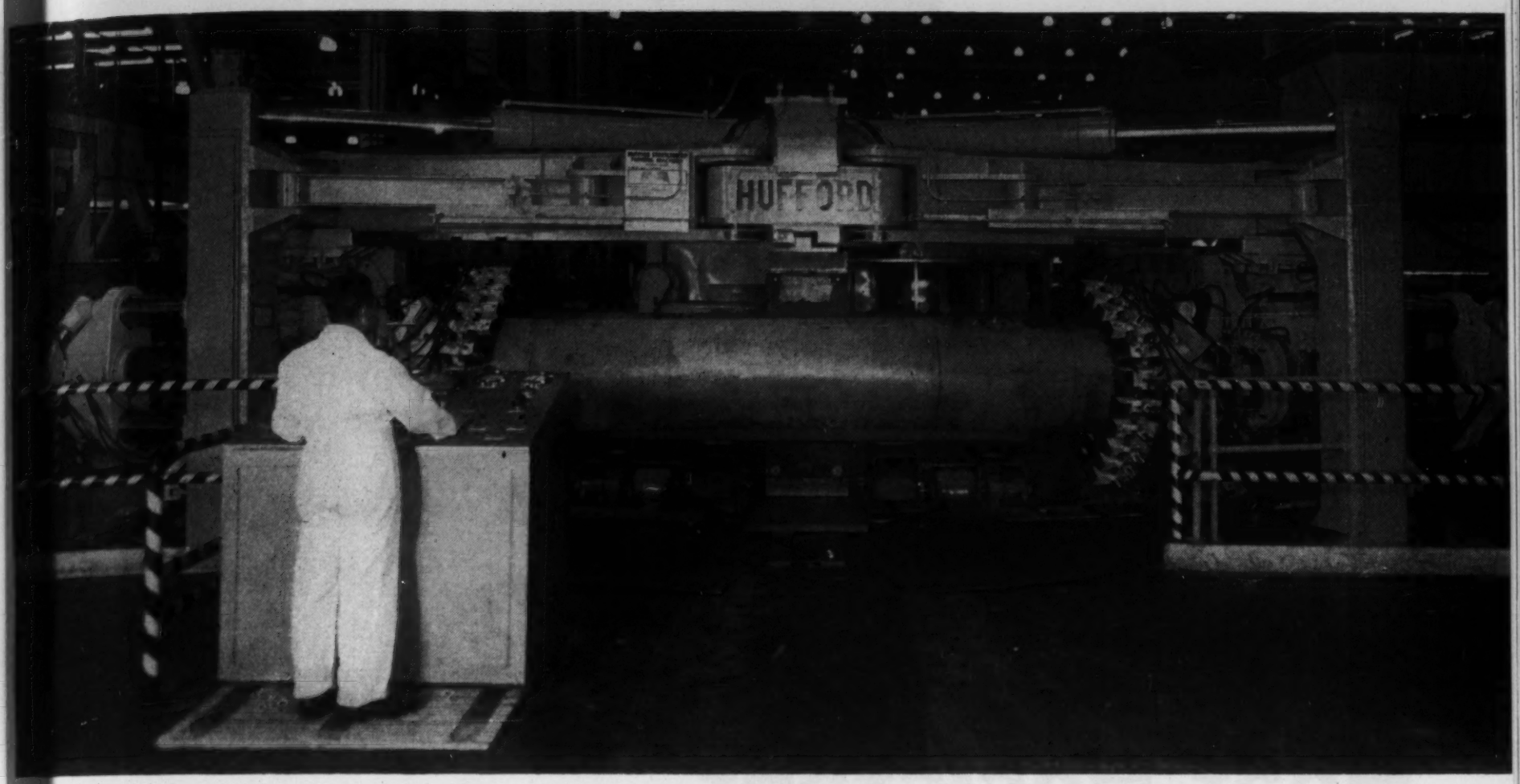
Information is coded on the card by punching away a portion of the card above the appropriate labeled hole. If the hole is in an outer row, it is coded by punching away that portion of the card between the hole and the outer edge of the card. Such cards are sorted out from a pack by inserting a needle in the specified hole and raising the needle; all cards with that hole punched out fall from the pack, while unpunched cards remain on the needle.

If the hole is in an inner row, it is coded by punching away the portion of the card between the inner hole and the corresponding outer hole (called "O-slot punching"). Such cards are sorted out from a pack by inserting a needle in the specified hole and raising the needle; all cards with that hole punched drop ¼ in. below the rest of the pack. They are separated from the pack by inserting a needle through one of the *lock* holes on the same edge of the card, withdrawing the first needle, and raising the second needle so that the punched cards drop out.

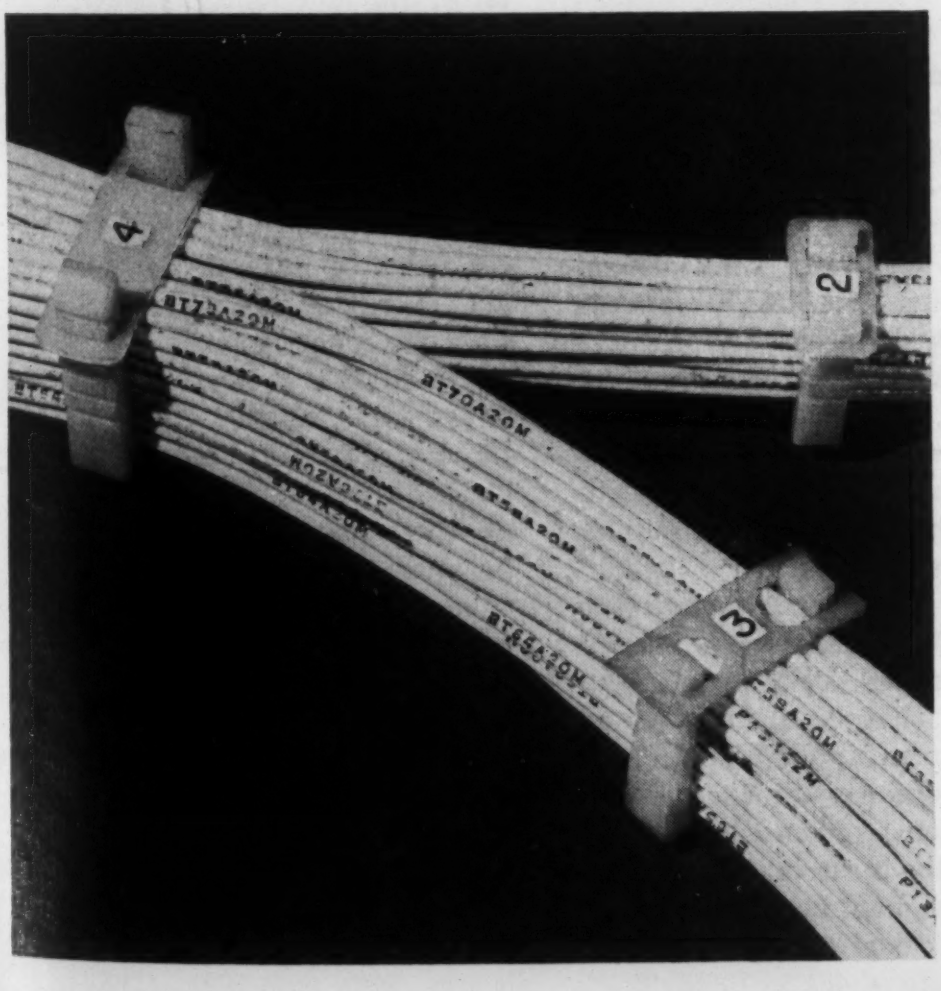
In actual use, several sorting needles may be used to sort several coded holes simultaneously.

This article is based upon information supplied by the indexing subcommittee of the Society of Aircraft Materials & Processes Engineers. Subcommittee members were:

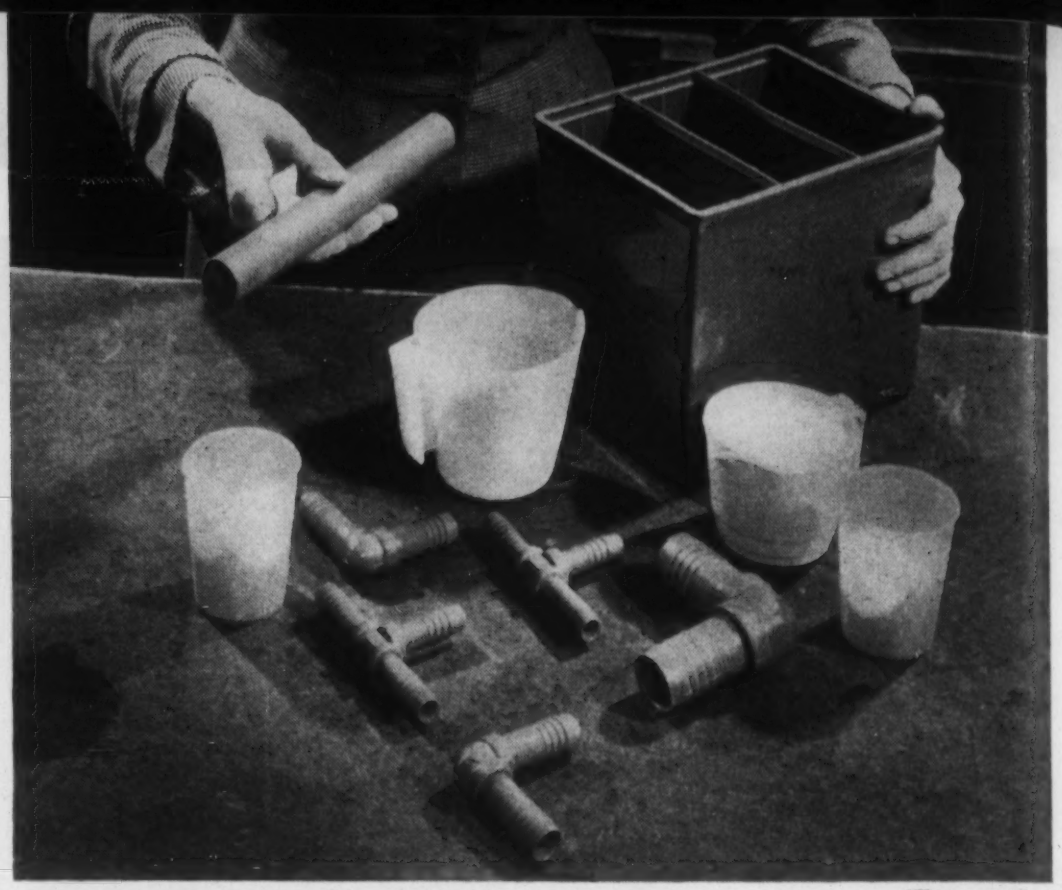
Jack K. Grace, North American Aviation, Inc.
S. E. Beal, Oakite Products, Inc. (Formerly of Douglas Aircraft Co., Inc.)
William H. Jones, Hughes Aircraft Co.
William E. Lassegard, Douglas Aircraft Co., Inc.
Charles M. Miller, Northrop Aircraft, Inc.
Robert A. Stewart, formerly Turco Products, Inc.
William V. Ward, Lockheed Aircraft Corp.



Titanium Gets Big Stretch Commercially pure sheets of 0.080-in. titanium sheet 177 in. long and 48 in. wide are being stretched at room temperature into complicated contours on this stretch press. The sheets, costing approximately $2000 each, are being formed by the El Segundo Div. of Douglas Aircraft Co. for use in nacelles of the DC-7 transports.



Nylon Cuts Installation Costs Lengthy jobs installing wire bundles in inaccessible areas in aircraft have been simplified by the development of two-piece self-locking nylon clamps. Designed and developed by Northrop Aircraft, Inc., the clamps are made in 3 sizes and are adjustable to handle a minimum-to-maximum number of wires. Locking and unlocking is done simply by hand. Dielectric properties of nylon plus its good strength, resistance to fungus and relatively light weight make it a good material for the job. *(Additional Materials at Work on p. 103)*



(Koppers Co.)

Pipe and fittings
Housings
Packages and containers
Housewares
Wire insulation
are among the potential uses of the new . . .

Rigid Heat-Resistant Polyethylenes

by John B. Campbell, *Associate Editor, Materials & Methods*

■ Take polyethylene, keep its light weight, its chemical inertness and its dielectric properties. But make it rigid. Increase its softening point, its strength, its toughness. Give it a glossy surface. Reduce its fluid permeability. The result? A new series of polyethylenes with a promising future. Two or three months from now it will be available in commercial quantities at a cost only slightly higher than that of conventional polyethylene.

A higher degree of crystallinity is believed to be primarily responsible for the higher properties of the new materials. The new polyethylenes are more than 80% crystalline, compared to only 60-65% for the old. Since the properties of polyethylene can now be varied over a wide range, the new polyethylenes will not only differ considerably from the old, but will also differ considerably among themselves. For example, their specific gravity (which reflects their degree of crystallinity) will range from 0.93 to 0.96, compared to 0.92 for conventional polyethylene. More meaningful is the expected range in stiffness (ASTM D747): from 50,000 to about 140,000 psi.

The new materials will eventually be available as molding compounds, sheet, film, rods, tubing and probably coating formulations (for paper). Although the number of different colors offered may be limited at first, the new materials should ultimately be available in many different colors, both translucent and opaque, depending on section thickness. Some of the first materials produced will not be available in "natural color" (translucent white), since a uniform appearance cannot yet be obtained in the process to be used by several producers. Price of some of the materials (in truckload lots) is expected to be about $.43 per lb for natural color and $.46 for colors, compared to $.41 for flexible polyethylenes in natural color.

Properties

Following is a brief rundown on the improved properties offered by the new polyethylenes:

Heat resistance — Softening points ranging from 240 to 260 F, compared to the 210-225 F range of the most heat-resistant flexible polyethylenes. Although flexible polyethylenes have been used successfully in nursing bottles that are sterilized in boiling water, they have not been able to withstand higher temperatures without losing shape (unless first irradiated). The new polyethylenes do not deform significantly at the steam sterilization temperatures of 250 F commonly used in hospitals and in the pharmaceutical industry. Dimensional change at such temperatures is about 2-4%.

Rigidity—Up to five times the stiffness of conventional polyethylenes. The most rigid polyethylene heretofore available had a stiffness of about 27,000 psi, and the stiffness of most polyethylenes

was in the 17,000-20,000 psi range. Although there is some doubt whether the term "rigid" should be applied to materials having a stiffness lower than 100,000 psi, from the standpoint of potential applications it seems a practical way to distinguish the new polyethylenes from the older, more flexible materials. Whatever the decision on semantics, it is well to note that the most rigid polyethylene now contemplated is still considerably less rigid than any other rigid thermoplastic.

Strength—About two to three times the strength of conventional polyethylene. Tensile strength in the 3000-5000 psi range seems to put these materials nearly on a par with some cellulosics and vinyls. Pipe made of the new materials not only has several times the bursting strength of conventional polyethylene pipe, but also loses strength less rapidly at elevated temperatures. The bursting strength of rigid polyethylene pipe at 212 F is reported to be about the same as the bursting strength of conventional polyethylene pipe at room temperature.

Fluid-permeability—Estimated to be about one-third that of conventional polyethylene. Although polyethylene carboys, bottles, bags and other containers have proved successful in many applications, some applications have been unsuccessful because of excessive fluid transmission. The new materials have greatly improved resistance to penetration by moisture, gases, oils and chemicals.

Surface appearance—A smooth surface far removed from the dull, waxy surface usually associated with flexible polyethylenes and approaching the glossy appearance associated with polystyrene can be obtained.

Improved low temperature toughness is another advantage that has been claimed for the new polyethylenes, but there is no general agreement on this point. Although brittleness temperatures as low as —180 F have been cited for the new materials, some evidence indicates that certain flexible polyethylenes may be equally good.

Some properties differ little from those of flexible polyethylenes. For example, rigid polyethylene retains the good dielectric characteristics of the flexible materials. It is no more weather-resistant or flame-resistant than its predecessor. Like the older materials, it has a "non-adhesive" surface; painting and printing require special surface preparation for good results, and bonding can be accomplished only by welding or heat sealing.

Molding characteristics differ considerably from those of flexible polyethylene. Mold shrinkage, although greater than that of polystyrene, is appreciably less than that of flexible polyethylenes. However, much higher molding temperatures are required. Injection molding temperatures, though no higher than those used for rubber-modified polystyrene, will probably be at least 50-75 F above those used for flexible polyethylenes.

Applications

In general, the new polyethylenes offer few properties not already provided by other plastics. What they do offer is an unusual combination of properties and price. It is because of this unusual combination, not any one outstanding property, that rigid polyethylenes undoubtedly will replace other plastics in many applications, and will replace other materials in applications not previously considered suitable for plastics.

In comparing the rigid polyethylenes with other plastics, specific gravity is an important factor. For example, the new materials will cost about 40% more than ordinary polystyrene and more than twice as much as phenolics on a weight basis. On a volume basis, however, rigid polyethylenes will be only 25% more expensive than polystyrene or phenolics, and about equal in price to the high-impact and rubber-modified types of polystyrene.

Typical of the applications now envisioned are:

Radio housings and toys that are more durable than those made of polystyrene and competitive with those made of rubber-modified polystyrene.

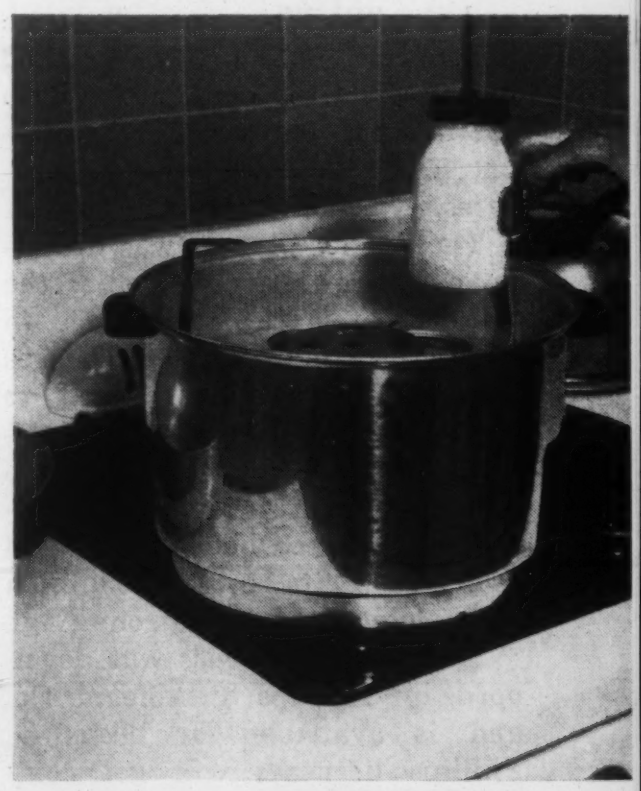
Pipe and fittings with much greater bursting strength than those made of flexible polyethylene, and competitive with materials such as cellulose acetate butyrate and polyvinyl chloride for many pipe applications.

Packaging films that are stronger, more heat-resistant, less vapor-permeable and more resistant to blocking than present polyethylene films.

Refrigerator parts that are tougher at low temperatures than those made of polystyrene, and more easily cleaned than those made of conventional polyethylene.

Battery cases as lightweight and chemical-resistant as, but considerably tougher than, modified polystyrene.

Bottles and carboys tougher, more heat-resistant, lighter and



***Even before** new production processes were introduced, new understanding of polyethylene had resulted in materials suitable for ever more demanding applications, e.g., this nursing bottle made by Royal Mfg. Co. that can be sterilized in boiling water.*

(E. I. duPont de Nemours & Co., Inc.)

less fluid-permeable than those made of present polyethylenes.

Wire and cable insulation more heat-resistant and less fluid-permeable than that made of conventional polyethylene.

Other possible applications: washing machine agitators, steering wheels, heater fans, air conditioner housings and parts for high-altitude aircraft.

Background

The new polyethylenes are the result of two major developments of recent years:

1. Low-pressure, low-temperature processes for the polymerization of ethylene.
2. New evidence concerning the molecular structure of polyethylene.

The production of polyethylene by the catalytic polymerization of ethylene has always been a difficult and expensive process. The conventional process utilizes a peroxide catalyst, pressures as high as 35,000 psi and temperatures of several hundred degrees.

About a year ago, two new processes—the "Ziegler process" and the "Phillips process"—were announced. Both utilize new and more effective catalysts. Both operate at approximately atmospheric pressures and temperatures.

The Ziegler process was discovered by Prof. Carl Ziegler of the Institute for Coal Research in West Germany. Ziegler licenses reportedly have been issued to about a half dozen chemical companies in this country. Since Ziegler did not develop any process details, each licensee has had to develop its own production technology from the ground up.

The Phillips process was developed by Phillips Petroleum Co. and is available for licensing. Phillips licensees will get complete information on process and plant design.

Despite the fact that high-pressure, high-temperature equipment is not needed, the Ziegler process, at least, is not less expensive but actually more expensive than the old method. The exothermic reaction still requires careful control to keep it from running away. Corrosion-resistant equipment and a separate catalyst plant are needed. In addition, there are still other production problems the producers do not care to discuss publicly at present. It has been estimated that the actual production cost of the new polyethylenes made by the Ziegler process is about 15% more than that of conventional polyethylenes, although it appears that the market prices of the materials will not reflect the entire cost differential.

The importance of the new processes, then, lies not in lower cost but in the vastly different type of material that can be produced. Primarily, the improved properties of the new polyethylenes seem to be the result of lower process temperatures.

For many years it had been known that polyethylenes polymerized under different conditions had markedly different physical properties. Furthermore, these differences were relatively independent of number average molecular weight as measured by viscosity, indicating that polyethylene was not a linear polymer.

In 1953, a group of duPont scientists suggested a picture of the polyethylene molecule that differed considerably from prevailing concepts and seemed to explain many of the apparent inconsistencies in earlier literature. By means of infra-red studies and light scattering measurements, the duPont researchers found considerable evidence to indicate that the average polyethylene molecule contains a good number of "short chain" branches (probably three to five carbon atoms) as well as a few "long chain" branches. The two distinct types of branches seem to occur by two different mechanisms, each subject to the conditions of polymerization.

Also, because of differences in size and frequency of occurrence, the short and long chain branches have widely different effects on the properties of the material. All the evidence suggests that at least three parameters — average molecular weight, degree of short chain branching, and degree of long chain branching—are needed

PROPERTIES OFFERED BY NEW POLYETHYLENES

Property	Test Method	Super Dylan	Marlex 50
Specific gravity	ASTM D792-50	0.93-0.95	0.96
Tensile strength, psi	ASTM D638-52T	2800-5500	5100[b]
Elongation in tension, %	ASTM D638-52T	400-100	28[b]
Stiffness modulus, psi	ASTM D747-50	50,000-100,000	140,000
Impact strength:			
Notched Izod, ft lb/in.	ASTM D256-47T	1.0-5.0	3.0
Unnotched Izod at 70 F, ft lb/in.	———	>32	—
Unnotched Izod at −85 F, ft lb/in.	———	>32	—
Tear strength, lb/in.	ASTM D1004-49T	600-1300	1020
Hardness, Shore D Durometer	ASTM D676-49T	63-70	65
Crack resistance at 122 F, wks	Bell Tel. Labs. Method	>1 wk[a]	—
Dielectric strength, volts/mil	ASTM D149-44 (short time)	—	510
Dielectric constant (1kc-80 mc)	ASTM D150-47T	2.2-2.3	2.35
Dissipation factor (1kc-80 mc)	ASTM D150-47T	<0.0005	<0.0005
Melt index, gms/10 min	ASTM D1238-52T	4.0-0.1	0.6
Dimensional stability, % change in vol	10 min at 250 F (steam)	2-4	—
Brittleness temperature, F	ASTM D746-52T	<−100	<−180
Flammability, in./min	ASTM D635-44	0.9-1.1	1.04
Deformation under load at 122 F, %	ASTM D621-51, Method B	0.40-0.05	—
Heat distortion temperature at 66 psi, F	ASTM D648-45T	—	165
Mold shrinkage (in direction of flow), in./in.	ASTM D955-51	0.012-0.025	—
Moisture vapor transmission, gms/100 sq in./mil/24 hr at 100 F	ASTM D697-42T, Method A	—	0.3

[a] *According to Koppers, experience indicates that this value forecasts "protracted to unlimited endurance".*
[b] *Injection molded, pulled at 20 in./min. Lower values were obtained for compression-molded material tested at same speed by ASTM D412-51T; materials tested at 0.2 in./min did not break when pulled to the limit of the testing machine.*

to describe the properties of polyethylene. Here is what the duPont researchers found:

1. Dependent primarily on degree of short chain branching: crystallinity or density. Crystallinity and its associated properties of yield point, stiffness, melting point and impermeability increase as the degree of short chain branching decreases.

2. Dependent on both number average molecular weight (measured by melt viscosity) and degree of long chain branching: ultimate strength and viscoelastic properties. Ultimate strength increases with increasing molecular weight and decreasing degree of long chain branching. Melt extensibility, i.e., the ultimate elongation of the molten polyethylene, decreases with increasing molecular weight and increasing degree of long chain branching.

3. Dependent on both molecular weight and degree of short chain branching: elongation, hardness and softening temperature of the solid. Ultimate elongation increases with decreasing density and increasing molecular weight. Both Vicat temperature and Shore Durometer hardness increase with increasing density and increasing molecular weight.

The duPont picture of the polyethylene molecule is not claimed to be complete or perfect. However, the last two years have seen the introduction of increasingly rigid and heat-resistant polyethylenes—an indication that the new picture, however imperfect, was being put to work. The faster, lower-temperature processes make it possible to go much further.

Who's doing what

At the moment, none of the new polyethylenes is available in commercial quantities. Koppers Co. and Phillips Chemical Co., a Phillips Petroleum subsidiary, have been working with molders for several months, and Koppers is currently shipping experimental quantities. Koppers, Union Carbide's Bakelite Co. and Dow Chemical Co., all Ziegler licensees, say they will have "reasonable" commercial quantities available this fall. DuPont, another Ziegler licensee, says it will have "evaluation quantities" available this fall. Phillips expects to be in production next spring.

Of the other companies currently producing or planning to produce conventional polyethylene, Eastman Chemical Products, Barrett Div. (Allied Chemical & Dye) and Spencer Chemical have indicated they have no present plans to make the new materials, and Monsanto Chemical has made no statement.

Present indications are that the first materials available will be of intermediate density. Koppers expects to produce its "Super Dylan" materials with a stiffness range of 50,000-100,000 psi, and Bakelite has indicated that its materials will be close to that range. By contrast, Phillips' first material, "Marlex 50", is expected to have a stiffness in the 125,000-140,000 psi range.

The different degrees of crystallinity in the materials being contemplated do not necessarily represent limitations of the two different production methods. Since molding temperature increases with crystallinity, it is necessary to strike a balance between improving service properties and decreasing ease of fabrication. It is entirely possible that each producer will settle upon a different compromise, and that this compromise may be changed as potential markets come into sharper focus.

Acknowledgment

The author gratefully acknowledges the considerable help given by personnel of Bakelite, duPont, Koppers and Phillips in the preparation of this article.

What About Irradiated Polyethylene?

The rigid polyethylenes arrived just about one year following the introduction of irradiated polyethylene. A comparison is inevitable.

Unlike the new polyethylenes, irradiated polyethylene is probably no more crystalline than conventional polyethylene. Instead its molecules are cross-linked to a certain limited degree, and it is these cross-links that make irradiated polyethylene an infusible material.

Irradiated polyethylene has only one significant advantage over conventional polyethylene at ordinary temperatures: much greater resistance to stress cracking. At elevated temperatures up to 250 F, irradiated polyethylene is stronger and stiffer than conventional polyethylene, but it probably offers no advantage over the new polyethylenes in that temperature range. Above 250 F irradiated polyethylene remains in a class by itself. Reportedly, it retains form stability at temperatures as high as 390 F.

Since irradiation must follow forming, it is clear that the new polyethylenes will be much more economical than irradiated polyethylene for applications where both are suitable. Some present applications of irradiated polyethylene, notably those involving exposure to boiling water or steam, may be already obsolete. On the other hand, there is no reason to expect that the new polyethylenes will displace irradiated film in higher-temperature applications, such as circuit breaker insulation.

References

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Symposium on "The Molecular Structure of Polyethylene", Journal of the American Chemical Society, 75, 6110-33, Dec. 20, 1953:

1. M. J. Roedel, "Chain Branching in Polyethylene during Polymerization".
2. W. M. D. Bryant and R. C. Voter, "Determination of Short Chain Branching".
3. F. W. Billmeyer, Jr., "Determination of Long Chain Branching".
4. J. K. Beasley, "Kinetic Calculations of the Effect of Branching on Molecular Weight Distribution".
5. C. A. Sperati, W. A. Franta and H. W. Starkweather, Jr., "The Effect of Chain Branching and Molecular Weight on Physical Properties".

Small Volume Production of Metal Powder Parts

Is it economical? *Engineers at Pitney-Bowes say it is if certain requirements are met.*

by B. I. Horton, *Pitney-Bowes, Inc.*

■ Experience at Pitney-Bowes has proved that small-volume production of metal powder parts is economically feasible. The traditional view has been that a run of over 10,000 pieces is required before the process can successfully compete with other methods. However, at Pitney-Bowes considerable savings have been realized with quantities of 10,000 per year or less. In many cases savings have been achieved with parts produced in quantities of only 1000 per year. The savings have ranged from 40 to 80%, and tool amortization time is less than two years.

The accompanying case histories give a cross section of the type of parts produced and the savings that have resulted from using metal powder parts.

We at Pitney-Bowes attribute our success with small-volume production of metal powder parts to four factors or requirements that we have adopted. The first requirement is designing the piece specifically as a metal powder part. Parts properly designed for the process involve fewer variables than those that are being made as a substitution for another process. The second requirement is good tool design and the workability of the tooling.

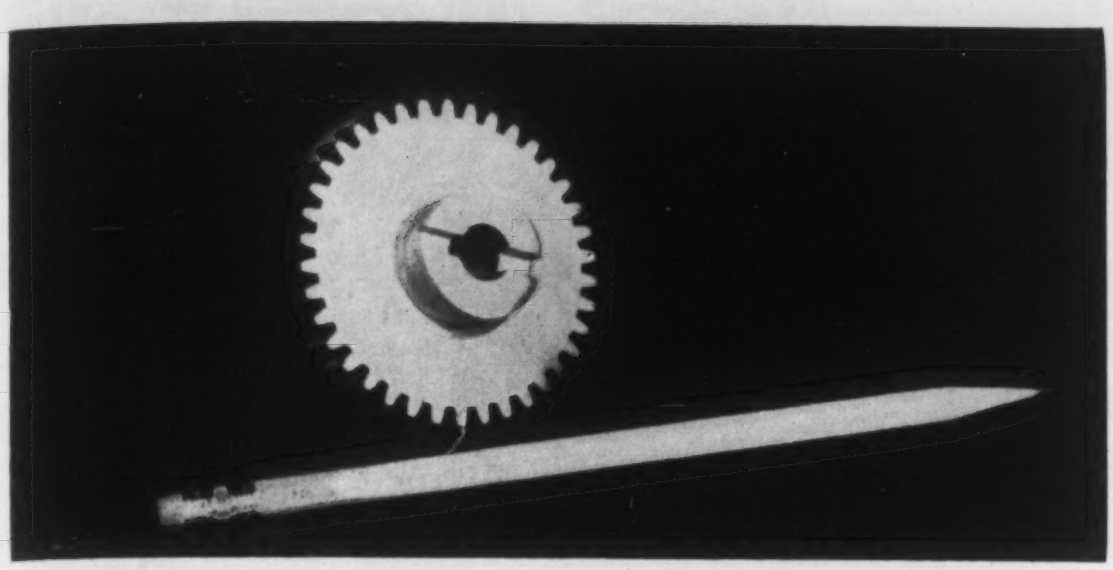
Background for Savings

Pitney-Bowes began to replace conventionally machined parts with metal powder parts about seven years ago. After purchasing several parts from custom fabricators for two years, the company established its own powder metallurgy department. Although total production was still low, cost comparisons at this point showed savings ranging from 10 to 90% over previous manufacturing methods.

By 1953 the department was making about 35 structural parts and 90 oilless bearings by powder metallurgy. Cost comparisons showed an overall saving of 47% for the previous year. A saving of 15% was realized on bearings when compared to similar parts purchased two or three years before. Savings of between 60 and 70% were made on the structural parts.

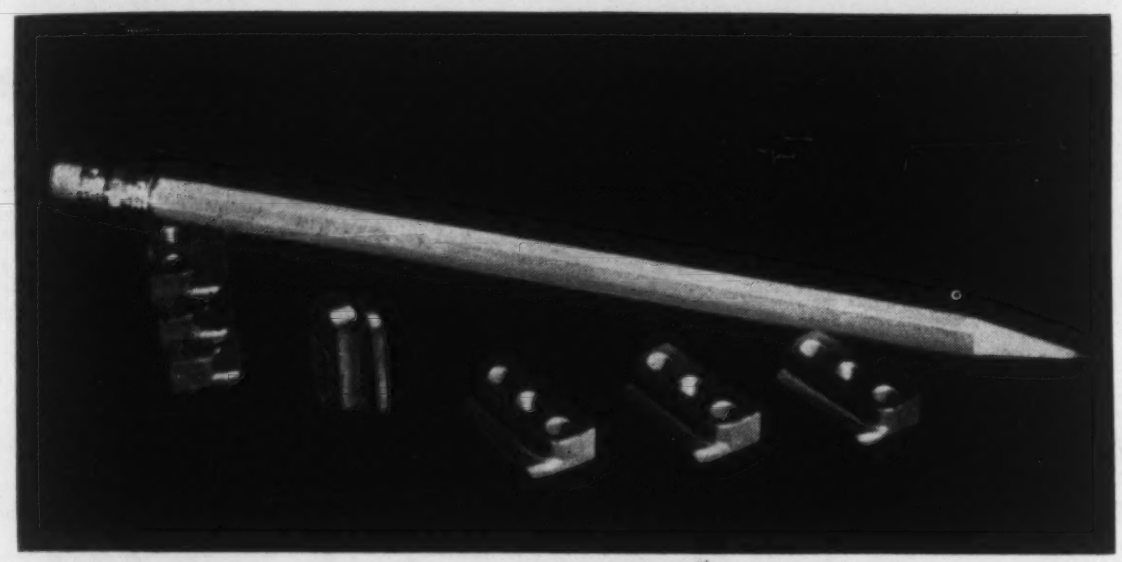
Because of the success shown, the department was expanded and additional equipment was purchased to carry the anticipated increased load. In 1953 and 1954 cost reports were again prepared, and they showed an average saving of 70% on 55 structural parts produced by powder metallurgy.

A large factor in the program's success was the method which Pitney-Bowes set up for operating the production of metal powder parts. After the initial phases of getting established, one man was appointed to control the entire program. It was his job to educate tool and product design engineers, approve or correct their designs, or reject them where the application or design was not suitable. He also made the necessary cost analysis to check the feasibility from an economic standpoint, to select tool sources and establish the required process specifications.



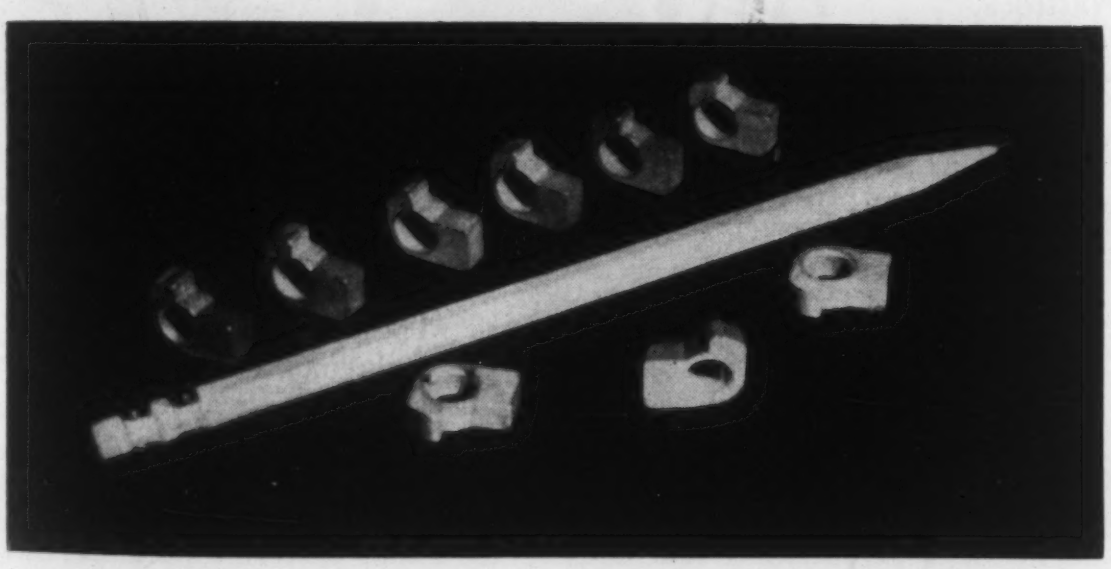
Meter Drive Gear

A 14 D.P., 14½ deg PA gear. Pitch diameter is 2.7142.
Quantity—8000
Former Method—Machined from a 1020 steel forging with a copper brazed-in hub
Tool Costs—$4000 to date, amortized in less than one year
Savings—60 to 80%



Meter Gib

Quantity—50,000
Former Method — Machined from 1020 steel forging
Tool Costs—$1500 to date, amortized in about 3 months
Savings—Approx 55%



Knife Cam

Quantity—5000
Former Method — Machined from 1020 bar stock
Tool costs—Approx $750, amortized in less than 1 year
Savings—90%

This, of course, is common to any type of powder metal production.

The third requirement is standardization. Some parts, such as oilless bearings, can often be standardized so that one set of tools can serve for numerous parts. When we standardized our oilless bearings for production, we found parts that differed in dimension only by tolerance. By eliminating these parts and numerous other bearings that could be readily substituted with a bearing of almost the same size, we were able to reduce the number of different bearings from 140 to 93. Standardization of inside and outside diameters aided us from a tooling standpoint by making possible production of 68 plain oilless bearings from only twelve sets of tools with additional punches and core rods.

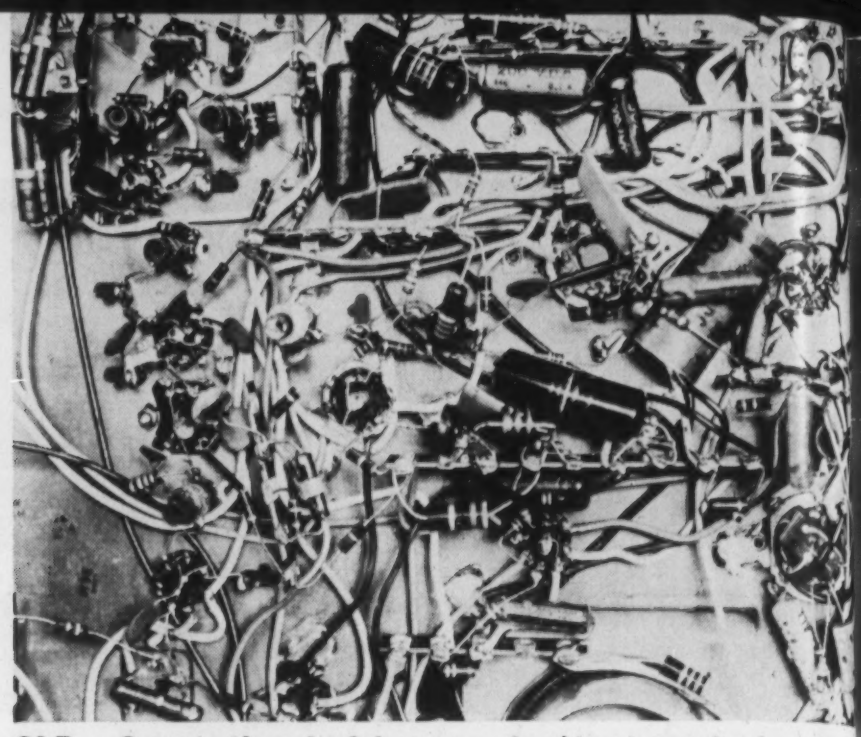
The last requirement which, we feel, directly contributes to a low production in-plant facility is process control. Strict process controls in the hands of a limited number of people will tend to eliminate variables and re-work, which in low volume production is very costly.

This article was adapted from a paper presented at the Annual Metal Powder Association Meeting in Philadelphia, May 10-12.

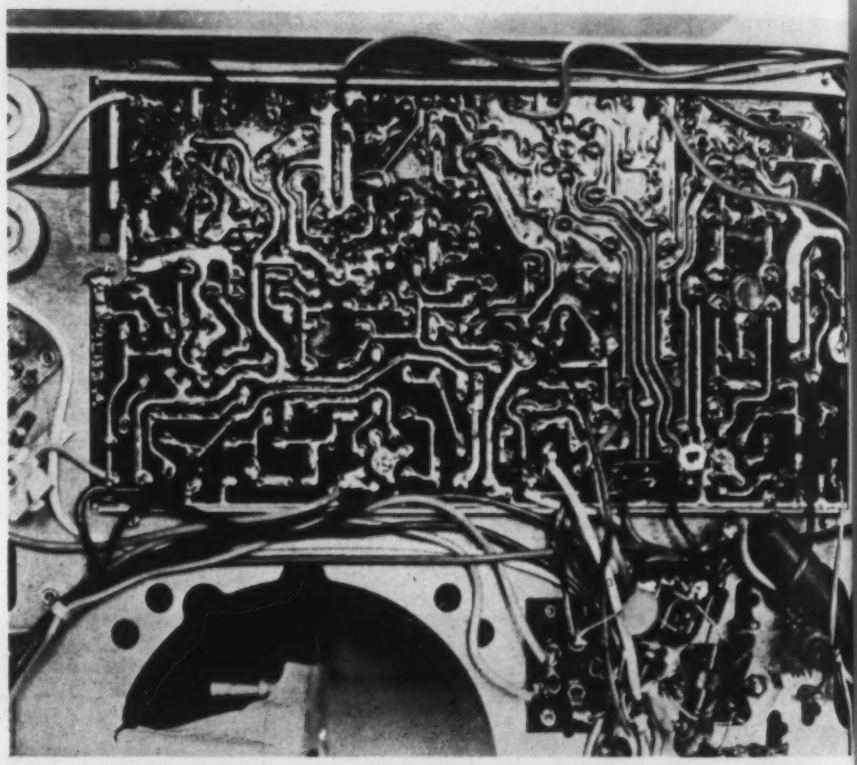
Materials for Printed Circuits

Here are the materials and techniques that are causing the electronics industry to revamp its production methods and streamline its products.

by Theodore B. Merrill, Jr.,
News Editor, Materials & Methods



OLD—Conventional wiring *on underside of metal television chassis requires hundreds of individual soldering operations.*



NEW—Printed version *of same circuit is assembled automatically and dip soldered in one operation.* *(Admiral Corp.)*

■ Printed circuitry has brought to the electronics industry a number of new production techniques offering remarkable opportunities for cost reduction, product improvement, miniaturization, and automatic production without sacrificing design flexibility. Printing, etching, embossing, stamping or plating a metallic conductor network on a suitable insulating base eliminates the most costly and time consuming steps in the production of electronic equipment.

The materials used in printed wiring and printed circuits are, as a rule, familiar to engineers. These materials fall into two classes: 1) the insulating and supporting base media; and 2) the conductive or resistive wiring or circuit media. In selecting a printed circuit system, the materials must meet the electrical requirements of the application, and must be able to resist the physical punishment of assembly and use under a wide variety of environmental conditions. While all printed circuit systems must withstand soldering temperatures for a short time, unit cost and service requirements for the completed assemblies are the most important factors in system and materials selection.

Techniques

A number of techniques for reproducing a conductive pattern on an insulating base are now in use. These include:

Etched wiring—The most widely used system, because of its low cost, basic simplicity and wide range of materials, etched wiring techniques involve printing an etch resist pattern on a metal foil clad insulating board, and etching away the unwanted metal. Etched wiring can be applied to one or both sides of a circuit board, and the etching process can be followed by electroplating to introduce refinements such as plated-through holes or hard silver, nickel or rhodium coatings.

Painted wiring—A true printed circuit, painted wiring consists of printing the desired circuitry on the insulator with conductive ink, usually graphite or metal powder

with a thermosetting binder. The system is often used to produce actual circuit elements, such as resistors and capacitors, in addition to wiring.

Plated wiring—When not simply an additional step in etched wiring techniques, plated wiring is produced by electroplating a metallic conductor, usually silver or copper, on a printed conductive surface. The relatively weak adhesive bond between insulator and conductor is often supplemented by plated-through holes or eyelets, which provide a mechanical bond.

Embossed wiring—Metal foil, either coated with adhesive or utilizing a separate adhesive sheet, is pressed into the surface of the insulator base by means of a raised and heated die. The excess foil and adhesive is milled off the base, leaving a flush circuit. This technique is useful for commutator patterns, brush switches, and other applications involving a moving contact that might scrape off raised conductor patterns.

Stamped wiring — A common production technique used in making stamped loop antennas for table radios, this method uses sharp-edged dies to stamp the circuit pattern into the insulator base. Like embossed wiring techniques, the base material for stamped wiring must be formable enough to be compressed without degradation of electrical or physical properties.

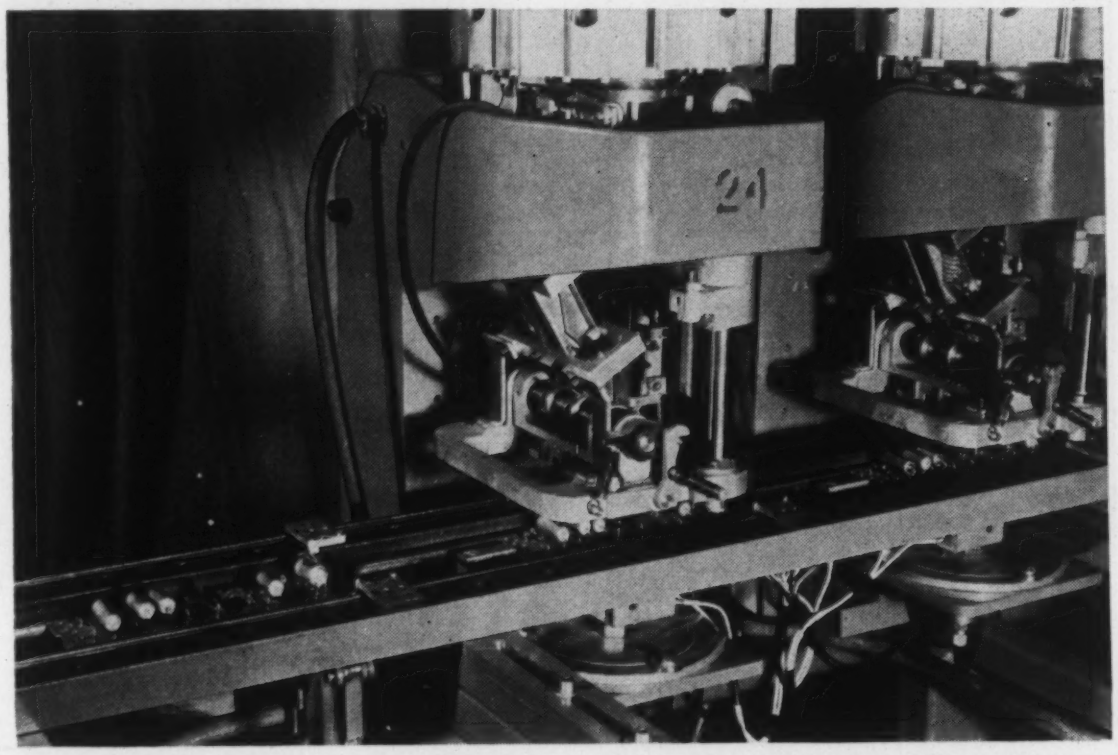
Metal powder, sprayed metal—Powder metal systems involve pressing the conductor in the form of powder into grooves in the insulator base, and heating the unit to sinter the powder. Sprayed metal techniques spray the conductor on a sheet with sunken grooves and subsequently mill off the excess, leaving the circuit pattern in the grooves.

While there are some variations and combinations of each type of printed circuitry, the list above includes, in general, all types of circuitry now in the production stage.

Most producers use the etched wiring technique, due to its simplicity, low tooling cost, and the wide variety of base materials available.

Conducting materials

At present, the most common conductor used for printed circuits is electrodeposited copper foil, in thicknesses of 0.00135 and 0.0027 in. (1 oz/sq ft and 2 oz/sq ft). Other thicknesses may be had on special order, but for most applications, the current carrying



Printed circuits *are well adapted for automatic production. Here, General Mills "Autofab" unit is completing assembly of 11 components on printed circuit board. A dip solder operation is final step.*

Foil clad phenolic sheets *36 in. wide have been printed with etch resist and are here inspected for flaws. Later, one dip in etchant will produce over 150 circuits at a time. Boards are then cut and punched.* *(Admiral Corp.)*

INSULATION-BASE MATERIAL PROPERTIES

Material	Max Oper Temp, F	Flex Str 1000 psi	Copper Bond Str (1 in. strip) 0.00135 in. Foil	Copper Bond Str (1 in. strip) 0.0027 in. Foil	Moisture Absorpt, % 24 hr	Punch Qual	Dimens Stab	Arc Resist	Diel Const 10^6, cps	Diel Str, v/mil	Cost	Dip Solder Data Max Temp, F	Dip Solder Data Time, sec
PAPER AND FABRIC LAMINATES													
XX Phenolic	250	18	4–8	6–12	1.3	F	G	P	5	—	Low	400–450	3–5
XXP Phenolic	250	17	4–8	6–12	1.0	Ex	G	P	4.5	—	Low	400–450	3–5
XXX Phenolic	250	15	4–8	6–12	0.8–1.3	P	VG–Ex	P	4.7	—	Low	400–450	3–5
XXXP Phenolic	250	19–23	4–8	6–12	0.55–1.3	F–G	Ex	P	4–5.5	85	Med–Low	400–450	3–5
Epoxy	250+	24.5	6–10	8–15	0.27	F	G	VG	4.3	820	Med	420	30+
GLASS FIBER LAMINATES													
Melamine	260	55	4–6	5–9	0.6–2.0	F	F	VG	6.8	—	Med	500	15
Silicone	300	40	1.5–7	1.5–7	0.2–0.3	F	VG	VG	3.5	—	Med–High	450—500	30
Polystyrene	170	—	2–3	2–3	0.5	—	—	—	—	—	—	—	—
Polyester	250	23	2–4	3–5	0.2	F	—	F	4.3	—	Med	—	—
Teflon	300+	—	1–3	1–4	0.3	—	Ex	VG	3.3	—	High	450 – 500	—
Epoxy	250+	60	6	6	0.24	G	Ex	VG	4	600	Med–High	525	30
NYLON FABRIC LAMINATES													
Phenolic	165	16	3–5	4.7	0.2	Ex	G	—	3.3	—	Med	400 – 450	5
INORGANIC													
Titanate	HI	—	—	—	—	—	Ex after cure	Ex	—	—	Low	Hi	—
Steatite	HI	—	—	—	—	—	—	—	—	—	Low	Hi	—
Glass Bonded Mica	650 F	—	—	—	None	Can be machined	Ex	Ex	—	—	Med–High	600+	—
Glass Bonded Synth. Mica	750 F	—	—	—	None	Can be machined	Ex	Ex	—	—	High	600+	—

capacity of the two standard grades of foil is adequate. The greater surface area for a given cross section of copper foil compared to wire enables the foil circuit to dissipate heat efficiently, which accounts for the high current capacities in the table.

FOIL CIRCUIT OVERLOAD RATINGS

Width, In.	1-oz. foil (0.00135 in.) Amps	1-oz. foil (0.00135 in.) Ohms*	2-oz. foil (0.0027 in.) Amps	2-oz. foil (0.0027 in.) Ohms*
¼	23	0.002	35	0.0009
⅛	15	0.004	20	0.0018
1/16	10	0.008	15	0.0035
1/32	5	0.016	8	0.007
1/64	3	0.032	5	0.015

** Ohms/in. for 100% IACS copper.*

Electrodeposited copper foil is the only copper material available in 36 in. widths at present. Its rough surface aids in gaining an adhesive bond, but the foil always contains pinholes, which allow small amounts of adhesive to extrude through during the laminating operation so that small areas on the top of the foil may be contaminated and interfere with etching and soldering. However, the large volume use of clad laminates for printed circuits has gained the interest of foil suppliers and some are planning to roll the copper foil in the thin gages. When and if they succeed, the rolled foil will eliminate the relatively minor problem of pinholes.

Etched, punched, and embossed copper foil circuits are often plated with silver, hard nickel, or rhodium to provide abrasion resistance for sliding contacts, such as commutator brushes. Silver foil is not generally used for etched circuits due to its high cost factor.

Conductive inks have considerably higher resistances than copper foil, usually in the range of one ohm per in. for a ⅛ in. strip. Printed resistors can be compounded to meet JAN-R11 tolerances, and can be applied to the insulator plate by silk screen process. A common use of conductive ink circuitry is in R-C circuit boards and in printed capacitors. The printed component system is particularly effec-

tive when used with a ceramic insulator, such as titanate, which will stand up under high temperature and high frequency. Copper clad plastics laminates are subject to more strict limitations in capacitor applications.

Silver inks, foil, and silver plated circuits exhibit one drawback—the phenomenon of silver migration. The Signal Corps and independent investigators have established that under certain conditions silver particles will migrate under the influence of direct current, building up conductive paths which can alter the value of printed capacitors and, in cases of closely spaced wiring patterns, actually result in shorting. Research now in progress has established some of the mechanisms of silver migration and it is generally expected that adequate protective measures will be developed.

Insulating materials

A wide variety of ceramics and reinforced plastics are used in the various printed circuit systems. The most widely used material is phenolic XXXP, a paper-based laminate. A number of proprietary grades of this material have been compounded especially for copper clad laminates for etched circuits, and these vary slightly in electrical properties and punching quality. The following chart gives a comparison of electrical and mechanical properties of printed circuit insulator boards available in the various laminates.

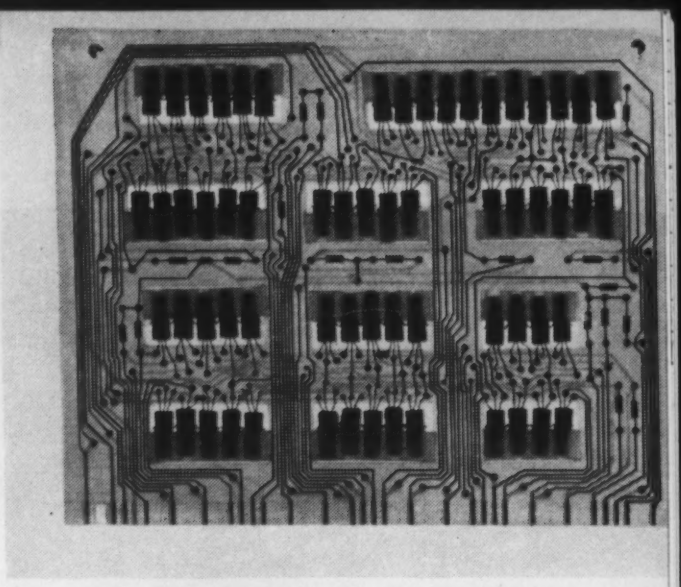
Nearly all materials listed in the chart are available under various proprietary trade names. Specific properties vary with the type of filler, resin-solid ratio, etc. The punching properties of phenolic laminates, for instance, vary from quite poor to very good, and as a rule, the better the punching quality, the lower the electrical properties. The chart deliberately omits surface resistivity figures, since these vary widely with the process and finishing coat applied to the circuit board. In etched circuits particularly, it is important to realize that the surface resistivity of the insulator board depends upon the adhesive used to bond the foil to the base as much as on the electrical characteristics of the base material itself. The etchant removes the copper, but does not remove the adhesive layer.

A great deal of work devoted to improving the base material and the base-to-foil bond is currently reaching fruition. Several epoxy-glass base materials show extremely good properties from both an electrical and mechanical standpoint, and will withstand soldering temperatures for more than 30 sec without degradation. Some grades of phenolics now have good cold punching characteristics. Both the electrical and bonding properties of adhesives have been improved significantly in the last few months. Laboratory and pilot plant processes now approaching production hold even greater promise. At least one improved bonding system which should be in large scale production before winter provides a bond that is stronger than phenolic laminate, and which actually increases in strength after it is exposed to the heat of dip soldering.

Soldering

Both hand soldering and dip soldering techniques can be used with most printed circuit materials. Because of the temperature sensitivity of most base materials and adhesives, close control of soldering temperature is necessary. Low melting solders near the eutectic point are required, and soldering time must be kept as short as possible to avoid blistering and delamination. Most fabricators are not satisfied with the limitation of four or five seconds now imposed, particularly for mechanized systems that have automatic dipping cycles.

For hand soldering, most printed circuit suppliers recommend a soldering iron heated to not more than 500 F with a tip less than ⅛ in. sq.

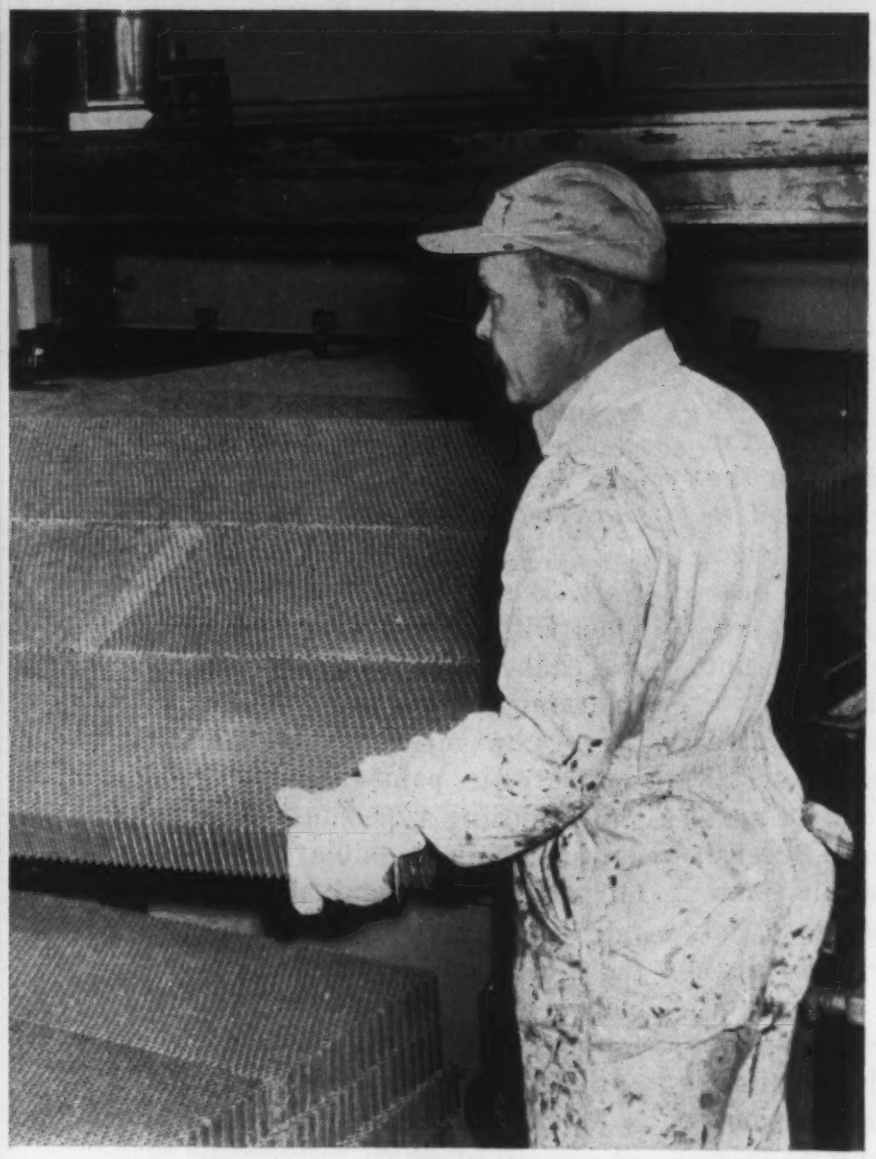


An epoxy-glass sheet *with etched circuits on both sides contains circuitry and leads associated with 64 transistors.* *(Philco Corp.)*

Coatings

In most printed circuit applications, it is advisable to use a protective coating to cover the exposed conductor pattern after soldering. Various shellac, varnish and other resinous coating materials are available which provide insulation, moisture resistance, and improved electrical properties for the surface of the insulator. Epoxy coatings have been particularly successful in this application, as they are extremely moisture resistant, impermeable, and have a very high dielectric strength. Circuit boards are usually designed so that the voltage gradient between two conductors is less than 1000 v/in., to prevent excessive leakage. An epoxy coating increases the surface resistivity of the insulator, so that voltage gradients up to 3000 v/in. will not exceed the margin of safety.

Painted silver wiring *on glass bonded mica base will operate at temperatures as high as 650 F without electrical degradation.*



1. *After expanding the core, segments are spliced by slitting, overlapping and compacting, and bonded together to form honeycomb of the correct size . . .*

2. *. . . to fit into the bonding jig. Cores can be sawed, machined and sanded to the proper configuration . . .*

by J. Joseph

Phenolic-Impregnated Paper Forms

This structural material is receiving increasing interest as the demand grows for light, strong materials. The author describes manufacture of the core material while the pictures show fabrication of finished sandwich panels.

■ Aircomb, a phenolic resin-impregnated kraft paper honeycomb material, is said to be the strongest material in relation to its weight now being manufactured. Although developed back in 1946 by Douglas Aircraft Co., it is now finding wider usage due to the increasing importance of reducing weight in airframes.

Compared to structural materials of the same rigidity, an Aircomb panel faced with aluminum is 1/16 the weight of steel, 1/10 that of aluminum and 1/5 the weight of birch plywood. With an EI rigidity factor of 792,000 steel might weigh 12 lb per sq ft and birch plywood 3.26 lb per sq ft. On the other hand, a 1-in. thick Aircomb panel faced with 0.016 in. aluminum has a rigidity factor of 792,000 and weighs only 0.75 lb per sq ft. The material withstands shear stresses and compression and tension loads normal to the panel face. Faces resist buckling under loads up to the yield strength of the facing material.

It has additional advantages of being fire, fungus and pest resistant and is unaffected by temperatures ranging from —65 to 250 F. It has high insulation and sound-absorption values, which can be increased by filling the honeycomb with foamed plastics.

It is currently being used in Douglas' DC-6 and DC-7's in stowage cabinets, partitions, cockpit floor panels, interior doors, cabin ceilings and for all types of tables. It is also used as internal strengtheners for fins on the Douglas Nike guided missile.

3. *. . . to receive edging and facing material which has been pre-coated with adhesive. Assembly takes place in this bonding jig; it is then sent through a bonding press. . .*

4. *. . . from which the finished aluminum-faced panels are removed and stacked, ready for use.*

High Strength Low Weight Honeycomb

How paper honeycomb is formed

Aircomb begins as either 60- or 125-lb, 18-in. wide rolls of long fiber kraft paper. Rolls are first run through a glue-line where a phenolic, water-soluble thermosetting adhesive is applied in 0.125-in. wide strips, staggered on both sides of the paper. The adhesive is then dried and the kraft passes through a cutter which slits the roll laterally into 3.2-to 6.4-in. folds, thus determining the thickness of the honeycomb. The sheets are then automatically folded and cured in an automatic high frequency dielectric oven. Curing bonds the lines of resin, producing a compressed, fan-like bundle.

The paper bundles are then expanded, either manually or hydraulically to fit in a magnesium form which may be 10 or 20 ft long. Magnesium is used because it resists the corrosive effects of a subsequent caustic cleaning operation. The form containing the core is then dipped in a tank of phenolic resin and agitated for 2 min at 70 F. After removal from the tank, it is agitated for another 2 min to remove excessive resin.

In the 85-ft curing oven, the first 40 ft of oven-travel cool the core, driving alcohol from the resin. A successive 25-ft section subjects the core to 150 F temperatures followed by the curing section which cures the resin at 300 F. Complete oven cycle takes from 12 to 18 min. The resulting core is stored for 5 days, then cut, sanded and fabricated in panels, or supplied without facing as a core material.

A wide variety of materials have been used as facing. These include almost all types of wood, aluminum, magnesium, glass reinforced plastics, and steel. Adhesives for bonding facings to core depend on the application of the panel.

Silver on stainless *being rolled to shape. Combination of fine silver on stainless backing plate could not be produced before vacuum brazing method of cladding was developed.*

New Clad Metals Made by Vacuum Brazing

Thinner alloy layers, new metal combinations and better surface finishes made possible by new cladding process.

by Kenneth Rose, *Midwestern Editor, Materials & Methods*

■ Clad plate made by a new vacuum brazing process is now available. Compared to more conventional types of clad metals the principle advantages claimed for vacuum braze-clad metals are:

1. Some of the metal combinations that can be produced by vacuum brazing cannot be made by any other cladding method, e.g., fine silver clad to stainless steel. A wide range of possible combinations makes it more likely that the most suitable material can be selected for service in a specific chemical environment.

2. Since the metal composite is not reduced or deformed in any way during bonding, corrosion life of the alloy layer is not reduced by "thinned-out" areas. Uniform thickness means that thinner cladding can often be specified.

3. The original surfaces of the individual metals are retained by braze-clad metals. Thus, a satin-finish stainless-clad plate free of surface contamination can be produced by vacuum brazing.

The new clad metals and the process by which they are made are known as "Hortonclad" and were developed by the Chicago Bridge and Iron Co. The new materials have been used successfully for several years in pressure vessels subjected to process temperatures up to 900 F.

Metals and sizes

The most widely used combinations now being produced consist of nickel, nickel alloys, chromium steels, or chromium-nickel steels, all backed by carbon steels such as A-285 (Grade C), A-201 or A-212. Special materials that have been produced include Hastelloy B, C or F backed by carbon

Distillate drum *of monel-clad steel, 9 ft dia and 27 ft long, was made by the Hortonclad process.*

steel, and silver-clad stainless steel. On a laboratory scale, titanium has been clad to both carbon and stainless steels, and various rare metal combinations have been made successfully. Other combinations are being developed, and the producers say no metal combination can yet be considered an impossibility.

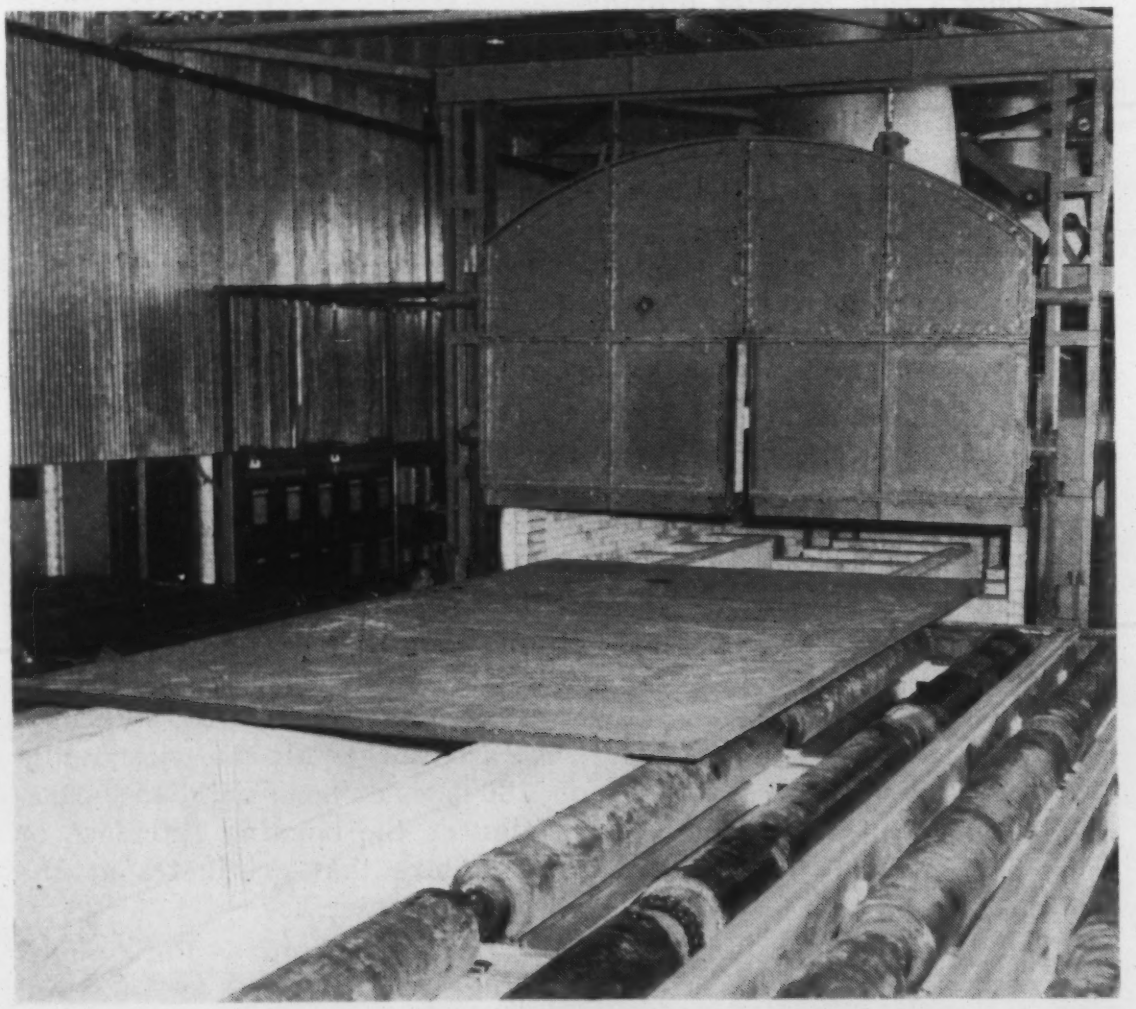
The vacuum-brazed composites can be produced in sizes up to 10 x 38 ft. Thicknesses specified generally range from ¼ to 1¼ in. for the base metal and ⅛ to ½ in. for the cladding, although these ranges do not represent process limitations.

These materials can be fabricated by welding and by conventional hot and cold forming methods such as rolling, pressing and bending. Composite plates have successfully withstood the most severe forming conditions ordinarily encountered in pressure vessel fabrication, e.g., forming a dished and flanged head, without destruction of the bond.

The bonding method

Key to these new clad metals is the vacuum brazing process.

Backing plate *about to enter the bonding furnace at Chicago Bridge & Iron's Birmingham, Ala., plant.*



The two metals to be bonded are placed in a furnace with a thin foil of brazing alloy between them. Brazing materials used include pure copper, brasses, bronzes, silver alloys and many pro-

prietary alloys. As the brazing alloy melts, a vacuum of 29-30 in. of mercury is drawn between the metals to be bonded and the two metals are forced together by the external atmospheric pressure.

Thus, the vacuum serves two purposes:

1. It draws away any gases, such as carbon dioxide, that may be liberated at the interface and might otherwise oxidize the bonding surfaces. By preventing oxidation, the vacuum eliminates both the need for a special introduced furnace atmosphere and the possibility of contamination by brittle flux particles often entrapped in conventional flux-brazing of large continuous surfaces. In some cases, the vacuum also seems to cause residual surface oxides to decompose and be removed as gases at elevated temperatures.

2. It provides uniform bonding pressure that is maintained throughout the brazing process. In copper and copper alloy brazing, this bonding pressure means that only a thin layer of brazing alloy is required, and excess brazing material tends to be drawn off by the vacuum. The thin layer permits a higher proportion of the brazing material to alloy with steel than in conventional brazing and, consequently, produces joints having higher shear strengths for equivalent brazing cycles. Whereas shear strengths of ordinary brazed joints range from 20,000 to 30,000 psi, vacuum brazed joints having shear strengths of 40,000 psi or more can be obtained without holding the plates at the brazing temperature long enough to cause excessive penetration of brazing alloy, excessive grain growth, or excessive carbon migration.

Copper penetration of various metals and alloys differs and must be controlled by careful attention to such factors as the placement of the brazing material, the thickness of the brazing material, and the brazing cycle itself. In stainless-clad metals, the copper or copper alloy not only bonds the two metals but also serves as a barrier to carbon migration from the base metal. In *rolled* stainless-clad, the same function is performed by a layer of nickel plated on the stainless prior to cladding.

Unlike conventional cladding methods, the vacuum brazing process requires no heavy rolling equipment, soaking pits or other typical steel mill equipment. Size of plates is limited only by the size of the brazing furnace cavity itself, and little steel or critical alloy materials are wasted through trimming to size after bonding.

Properties of composites

Metals clad by vacuum brazing reportedly have mechanical properties well above the minimum values for integrally and continuously clad plate established by the American Society for Testing Materials and the American Society of Mechanical Engineers. Their properties are also comparable to the properties of conventional types of rolled clad materials.

Tensile strength—The ASTM specifies that tensile strength of the entire clad metal must be at least equal to the minimum value set for the carbon steel backing used. Vacuum braze-clad metals have been used successfully with backing materials having minimum tensile strengths of 65,000 to 70,000 psi. In fracture, the alloy layer "necks down" with the carbon steel and does not split away at the bonding interface.

Ductility—The ASTM specifies that a clad metal withstand a 180-deg bend around a radius that depends on the thickness of the metal, tests being conducted with the alloy layer both in tension and compression. Vacuum braze-clad metals can withstand a 180-deg flat bend without separation at the bonding interface or a failure that originates at the bonding interface.

Shear strength — For plates ranging from 3/16 to 1-5/8 in. in thickness, shear strength of vacuum braze-clad plates produced so far ranges from 35,000 to 60,000 psi, the average being about 45,000 psi. An average of about 40,000 is considered sufficient for all ordinary pressure vessel applications. Higher shear strengths can often be obtained by adjusting the brazing cycle, but too large an improvement would tend to result in a brittle bond layer. High welding temperatures used in joining lugs or other attachments to the alloy layer do not seem to affect the bond layer below sufficiently to cause any loss in shear strength.

Impact resistance—In ordinary furnace brazing with copper or copper alloys, the transition temperature of the base steel is sometimes raised into the service temperature range. Charpy keyhole notch type impact tests on common backing steels subjected to the controlled heating cycles that are part of the vacuum brazing process have shown transition temperatures well below the ordinary service temperature range and in line with transition temperatures found for the same steels in the normalized condition.

Thermal shock—Vacuum braze-clad metals have been subjected to thermal shock by heating them to 1650 F, holding them at temperature for 30 min, plunging them into cold (56 F) circulating water, and repeating this procedure five consecutive times. Despite the differences in thermal coefficients of expansion between the two metal layers, the clad metals have shown negligible loss in shear strength after these tests.

Other tests that have been met successfully by these materials include torsion tests, elevated temperature shear tests at 1000 F, pressure tests on the alloy layer, welding tests, tensile strength tests on the copper alloy bonding layer, and extensive corrosion tests.

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ASTM Standards, 1952 (A 263-44T, A 264-44T, A 265-44T)

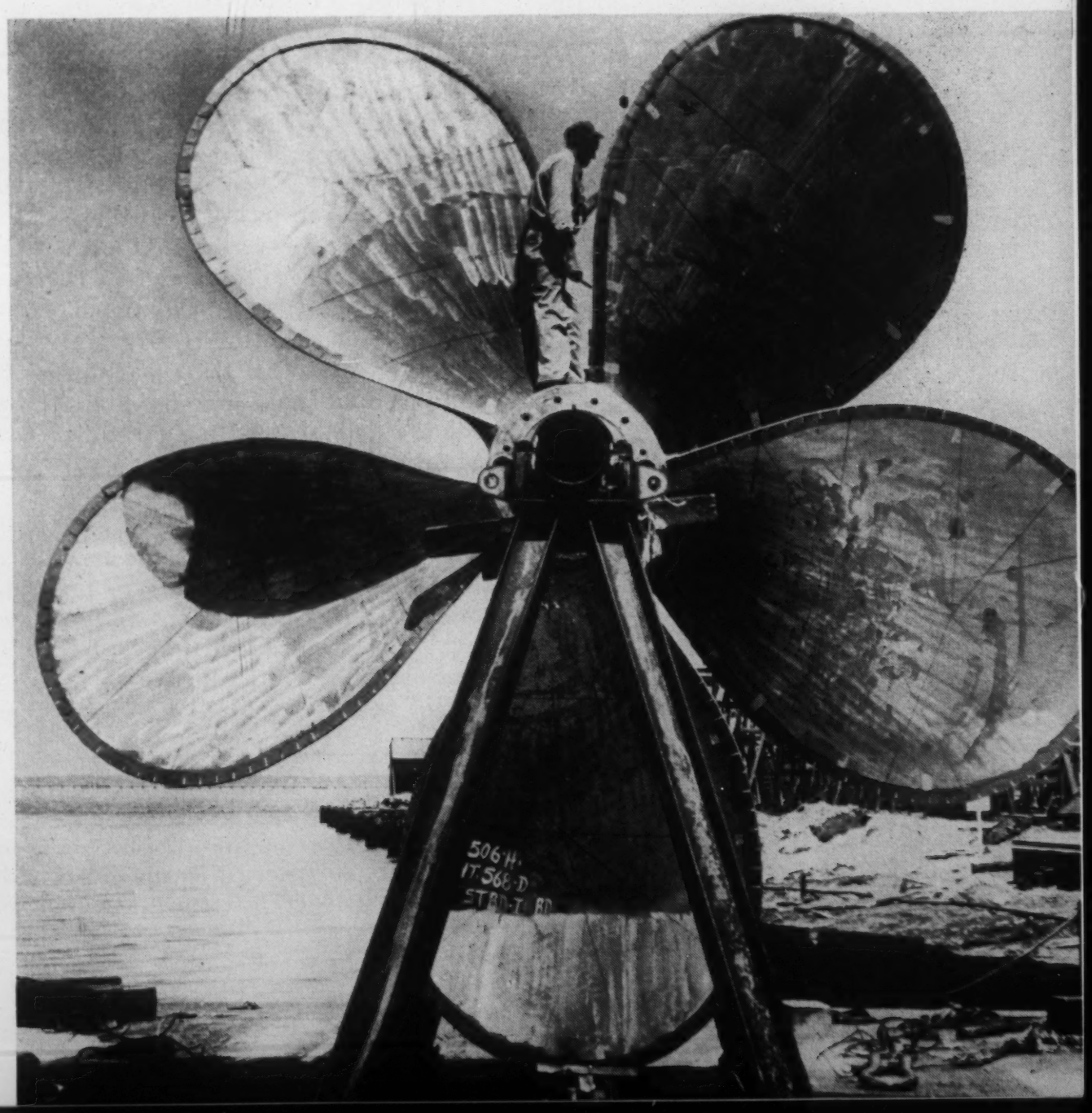
R. C. Bertossa, "High-Strength Vacuum Brazing of Clad Steels", *Welding Journal*, Oct. 1952, pp 441-s to 447-s.

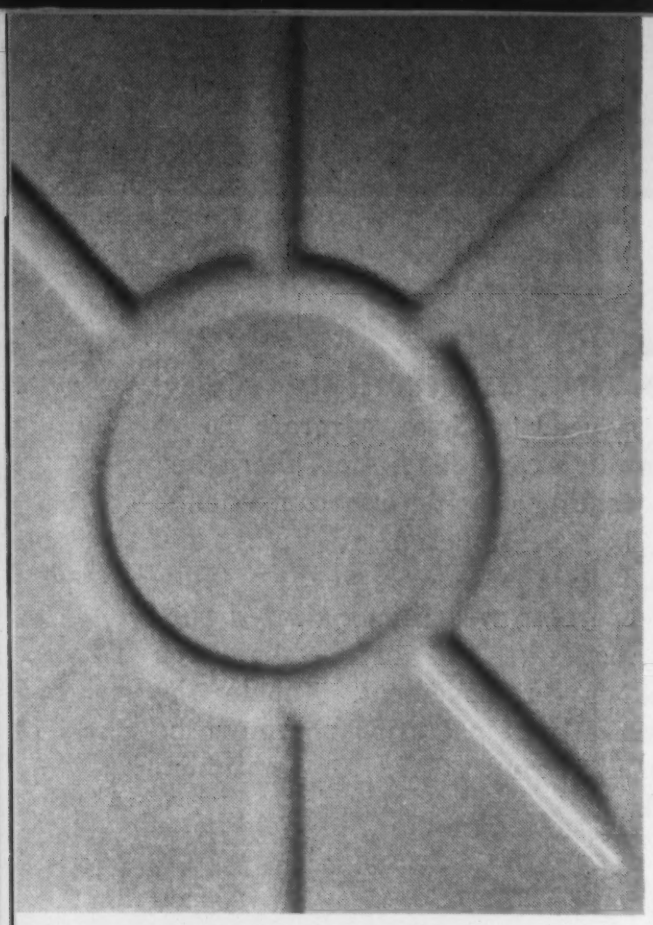
Plastics Aids Welding of Titanium

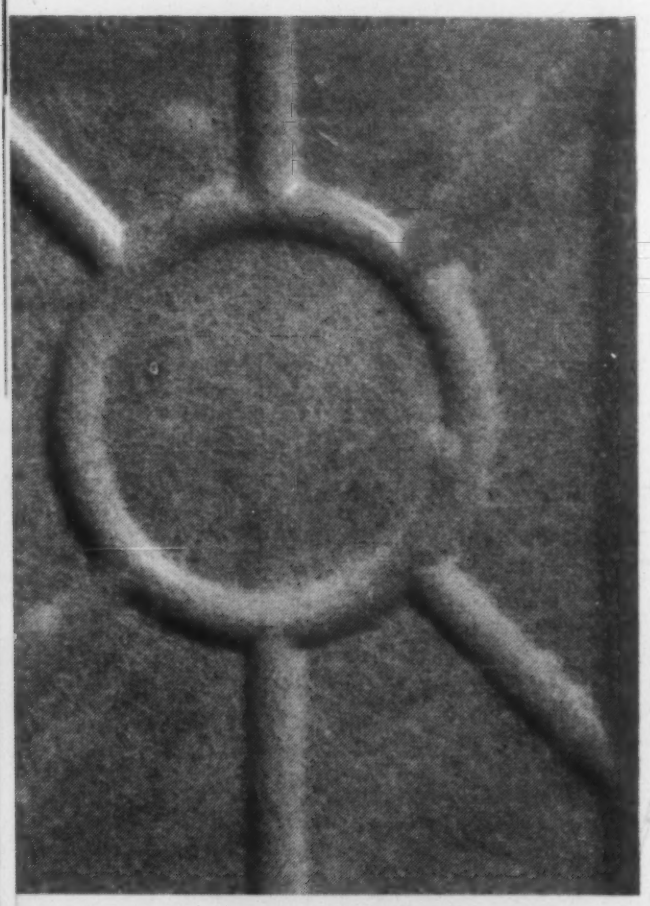
A vinyl bag is used by Solar Aircraft Co. to maintain a controlled atmosphere during welding of titanium components. The bag is zippered, gas-tight, and sealed to a standard welding table. The operator wears long-sleeved rubber gloves, sealed to the bag, for freedom of movement. Inside the tent, the inert gas atmosphere can be carefully controlled for optimum welds.

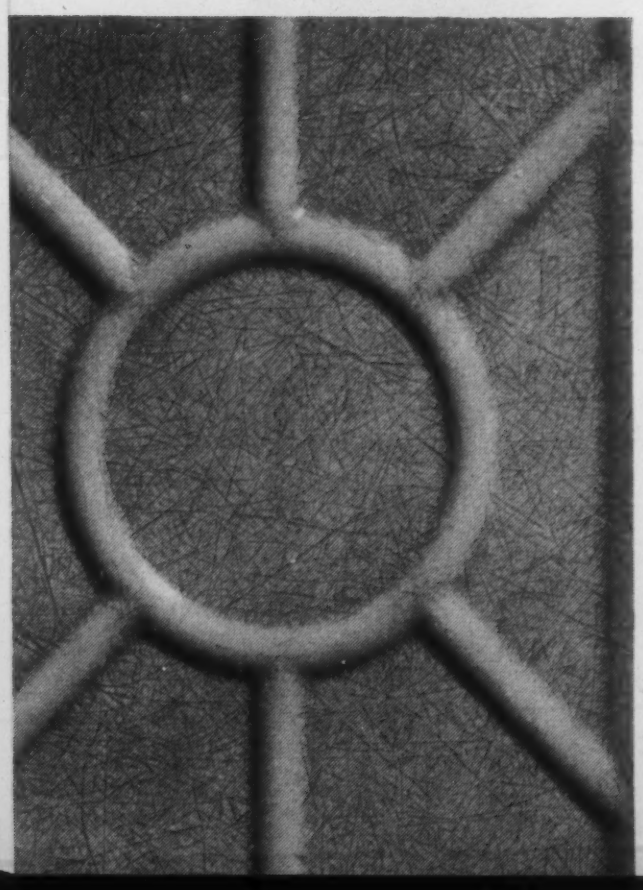
Big Bronze for Super-Carrier

Four of these giant cast manganese bronze, variable-pitch propellers are used to drive the U.S.S. Forrestal, first of the super aircraft carriers. Weighing 70,000 lb, with a 21 ft diameter, the propellers were built by Baldwin-Lima-Hamilton Corp. Power for driving the props is supplied by a 200,000 hp propulsion plant with a generating capacity sufficient for a city of 1.5 million population.









New Molded-In Finish for Reinforced Plastics

Low cost laminating technique hides cloth and mat reinforcements . . . provides enamel-like finish.

by J. S. Bowen, *Research Director, Lunn Laminates, Inc.*

■ A low cost laminating technique has been developed to provide the reinforced plastics industry with an effective way of hiding glass cloth or mat reinforcement in polyester laminates. The resulting parts have an enamel-like, wrinkle-free finish. The purpose of the technique is to eliminate costly painting and finishing operations on those parts which must compete with parts made of other materials with a smooth homogeneous finish. Called Lunn Finish #107, the process does away with buffing, sanding and painting in press molding and vacuum bag forming operations.

How it is done

The technique involves the use of a non-woven cotton fabric to cover the glass reinforcing material. The material found to be most satisfactory is called Webril R, and is manufactured by Kendall Mills Co. It is available in different weights and densities, calendered and uncalendered. Webril Grade R-2801 uncalendered gives superior results when proper manufacturing methods are used. It is a composition of pure bleached cotton fibers providing satisfactory laminating strength. Full resin saturation is possible with the material, resulting in a laminated structure of low moisture absorption.

It is important to combine all the materials carefully to produce the best results. Webril R-2801 is placed so that it becomes the working face of the molded piece. In female molds, assuming the working face is to be on the outside of the plastics part, the Webril material should be laid in the mold first. Glass mat or glass preform is then placed over it. Resin is then poured in a pattern to facilitate flow. A well-made preform and adequate resin pro-

Compare *the smooth, print-free surface provided by new technique (top) with that of a typical laminate (bottom) where glass fibers show prominently and mat bridged on ribs. In center is unsatisfactory finish produced with non-woven fabric which had been calendered. Note density of fabric, which caused a reduction in resin penetration permitting air to be trapped.*

duces a satin smooth surface concealing all mat prints.

In male molds, the glass mat or preform is placed over the mold first, followed by application of resin and Webril. If the print-free surface is desired on both sides of the part, Webril and glass reinforcing are applied first, followed by resin and another layer of Webril.

Where it can be used

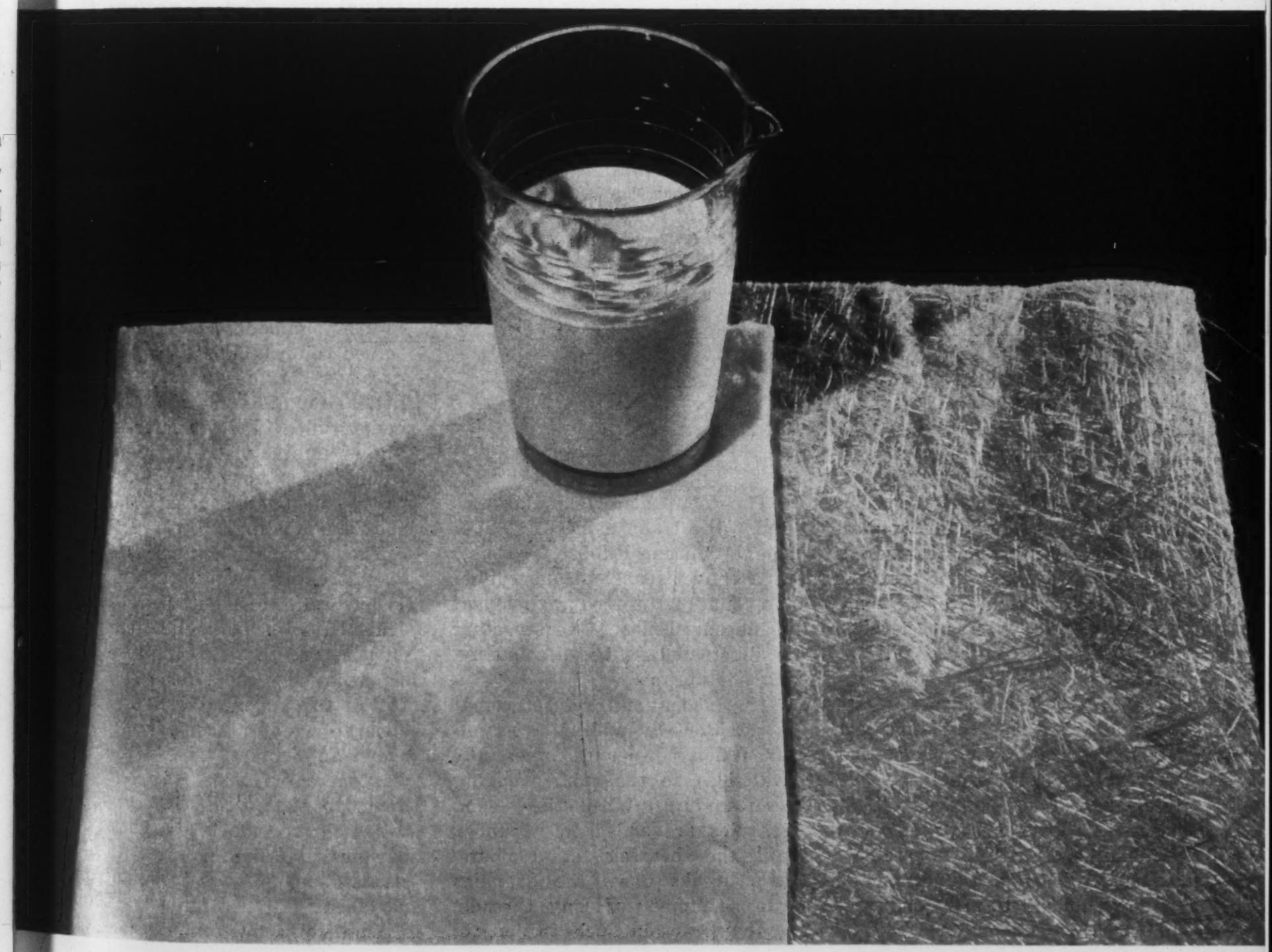
Lunn Finish #107 can be obtained in matched metal molding and vacuum bag molding. Its flexibility enables it to conform to flat sheets and shallow contours, complex or irregular. Considerable difficulty has been encountered in obtaining satisfactory results on deep drawn matched metal moldings, due to thinning of the Webril material and accumulation of resin in corners and pockets.

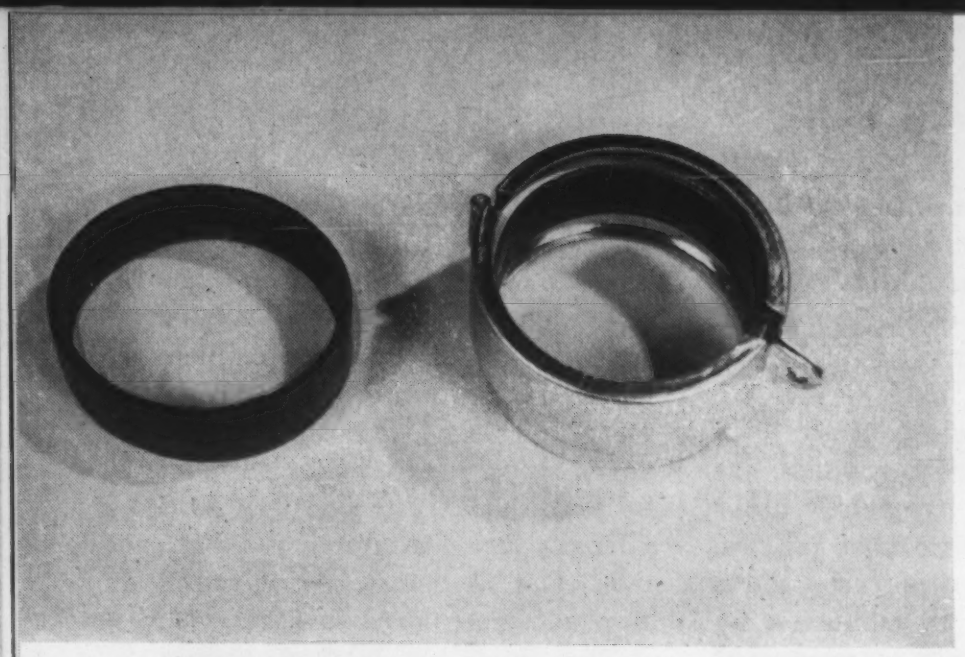
A similar type of finish with increased chemical resistance has been developed by using other non-woven synthetic fiber fabrics. Though reinforced polyester parts are protected from corrosion by a homogeneous skin of resin over the glass, erosion during use may expose some of the glass fibers. Fibers can then provide a wicking action to introduce corrosive material into the part. By using a non-woven fabric of nylon, Dynel or Orlon, in the same way Webril is used, glass reinforcing is depressed further from the surface of the part and improved corrosion resistance is coupled with a smooth, print-free finish.

The impregnating resin may be clear or colored, filled or unfilled. When using fillers, particles must be small. Particle sizes up to 5 microns are satisfactory. Both fillers and resin may be pigmented to produce a colored surface.

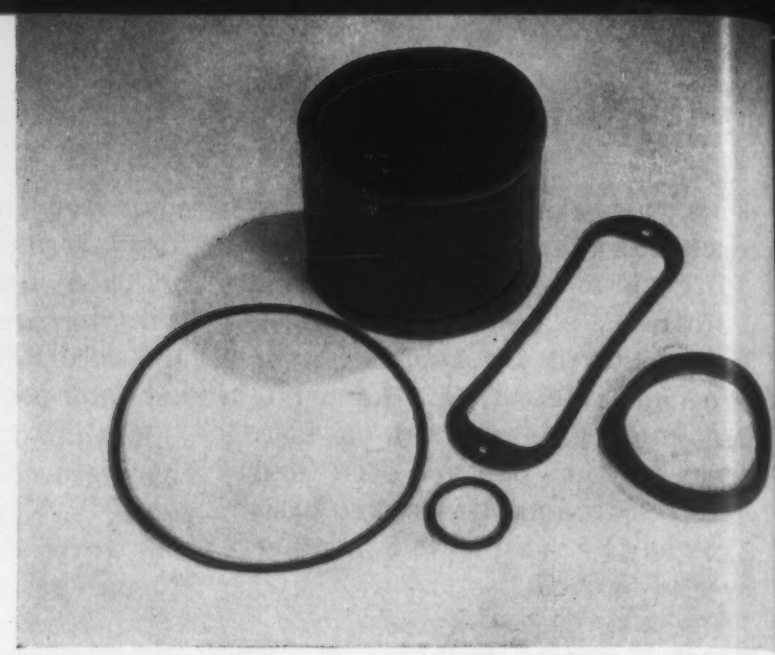
The finishing method should find wide application among plastics fabricators who spend extra dollars in labor and time to paint the surface of finished products. Among potential applications are automotive parts, boats, vending machines.

***Ingredients for producing** Lunn Finish #107 are glass fiber mat, uncalendered pure bleached cotton fibers and polyester resin.*





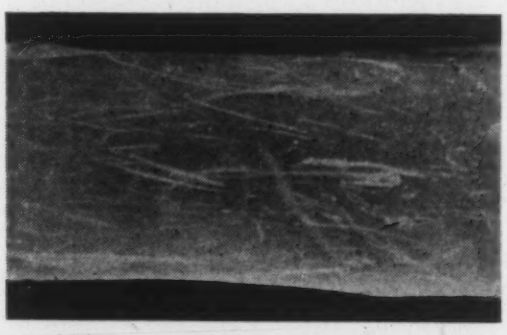
Clamp liner *molded from new silicone rubber compound. Assembled clamp is shown at right.* *(Rubber Teck, Inc.)*



Seals and gaskets *molded from Teflon-reinforced silicone rubber.*

Tear-Resistant Silicone Rubber

Fibrous Teflon reinforcement multiplies tear strength, also boosts oil resistance without sacrificing other service properties.



Fiber distribution *is shown by this view of translucent silicone rubber stock (10X).*

by George S. Irby, Jr., *Plastics Dept., General Electric Co.*

■ A major deterrent to the use of silicone rubber in many applications has been its low tear resistance. Now, this problem seems to have been overcome to a considerable degree with the development of Teflon-reinforced silicone rubber.

Silicone rubber reinforced with tetrafluoroethylene resin has tear strength three to four times that of regular grades of silicone rubber, as well as improved oil resistance. Other end properties of the material are not appreciably affected, although the compound is more difficult to mold than regular silicone rubber.

The new material, marketed under the trade name of "Super Tough Silicone Rubber," consists of a conventional silicone rubber compound reinforced with a mat of fibrous Teflon. The structure is illustrated in the accompanying photograph.

The Teflon mat reinforcement is achieved by adding a granular Teflon powder (commercially available) to the rubber during compounding. When the Teflon granules are added on a rubber mill, the shearing action of the rolls breaks down the granules into a number of long threads, some up to an inch in length. These threads are tough and elastic. Continued milling breaks down these initial threads into finer threads. The fine threads become intermixed and, with proper compounding technique, form a reinforcing mat. Although the effect of various fillers on the reinforcing action of the Teflon has not yet been pinned down, the best end results seem to be obtained with compounds having silica fillers.

Properties

The Teflon-reinforced compound has different handling characteristics than regular compounds. Whereas a regular compound is soft and puttylike when properly milled, the Teflon-reinforced compound is tough, has a great deal of "nerve" and exhibits little flow. The material cannot be extruded, and transfer molding is impractical. With proper techniques, however, excellent parts can be produced by compression molding.

The remarkable increases in tear strength resulting from the Teflon reinforcement have been achieved with both the general-purpose and the low-compression-set types of compounds. The effect of the Teflon addition on one general-purpose compound is shown in Table 1. Tear strength was increased 280%— from 50 lb/in. to 190 lb/in. Other properties showed much less change: hardness up five points, tensile strength up 36% and elongation up about 20%. Similarly, tear strength of a low-compression-set

compound (Table 2) was increased 25%— from 50 lb/in. to 175 lb/in.

Silicone rubber has always shown good oil resistance compared to other elastomers, particularly at temperatures over 300 F, but the oil resistance of Teflon-reinforced compounds is better than that of regular silicone rubber compounds. As shown in Table 3, tear resistance is reduced only 25% by 70-hr immersion in MIL-L-7808 aviation oil at 300 or 350 F. Compression set and electrical properties are not affected, and there is no major effect on other properties. Thermal stability is excellent and fully equivalent to that of other grades of silicone rubber.

Uses

The high tear strength and improved oil resistance of this material have opened up possibilities for many new applications of silicone rubbers. Among the most promising are:

1. "O" ring seals for aircraft engines where the use of synthetic-base lubricating oils has created major sealing problems. The Teflon-reinforced material has been tested by almost every major aircraft engine manufacturer and is now being used extensively on the T-40 turbo-prop, J-71 turbo-jet and J-46 turbo-jet engines. In some cases, no other material was successful.

2. Rubberized ducts and air duct clamps for aircraft heating and de-icing systems, where good thermal stability and oil resistance are required. Air duct clamps with Teflon-reinforced silicone rubber liners are being used on the F-84 fighter.

3. Gaskets for aircraft brakes. Both civilian and military aircraft will soon be equipped with such gaskets.

4. Gaskets for chemical and other process equipment, where high temperatures, corrosive chemicals and vacuums are encountered.

This article is based on a paper given at the 1955 annual meeting of the Society of Plastics Engineers and published in the SPE Journal.

TABLE 1—EFFECT OF TEFLON ADDITION ON GENERAL-PURPOSE TYPE

	Conventional	Teflon-reinforced
COMPOSITION (parts by weight)[a]		
SE 76 silicone gum	100	100
Santocel CS	42	42
Benzoyl peroxide	1.6	1.6
Teflon TE 3086	—	10
PROPERTIES		
Hardness, Shore "A" durometer	50	55
Tensile strength, psi	750	1020
Tear strength, lb/in. (Die "B")	50	190
Ultimate elongation, %	250	300

[a] *Both cured 24 hr at 480 F.*

TABLE 2—EFFECT OF TEFLON ADDITION ON LOW-COMPRESSION-SET TYPE

	Conventional	Teflon-reinforced
COMPOSITION (parts by weight)[a]		
SE 30 silicone gum	100	100
Celite 270	140	140
Mercurous oxide	1.7	1.7
Benzoyl peroxide	1.7	1.7
Teflon TE 3086	—	10
PROPERTIES		
Hardness, Shore "A" durometer	75	80
Tensile strength, psi	750	900
Tear strength, lb/in. (Die "B")	50	175
Ultimate elongation, %	80	100
Compression set in 70 hr at 300 F	25	25

[a] *Both cured 24 hr at 480 F.*

TABLE 3—OIL RESISTANCE OF TEFLON-REINFORCED SILICONE RUBBER[a]

Property	Original Value	After 70 hr in oil[b] at 300 F		After 70 hr in oil[b] at 350 F	
		Value	Change	Value	Change
Hardness, Shore "A" durometer	80	70	−10	60	−20
Tensile strength, psi	1000	820	−18%	600	−40%
Ultimate elongation, %	250	275	+10%	125%	−50%
Volume	—	—	+20%	—	−27%
Tear resistance, lb/in. (Die "B")	200	150	−25%	150	−25%

[a] *Super Tough Grade 15080.*
[b] *MIL-L-7808 aviation oil.*

Careful loading of castings *before solution treatment prevents distortion.*

(All photos courtesy Fischer Casting Co.)

Solution treatment *at carefully controlled temperatures produces a casting with a homogeneous structure.*

Improve Cast Aluminum Alloys by Heat Treatment

Use:

- *Solution and aging treatments to obtain better mechanical properties.*
- *Stress relief to maintain dimensional accuracy.*
- *Stabilizing to obtain low stress level.*

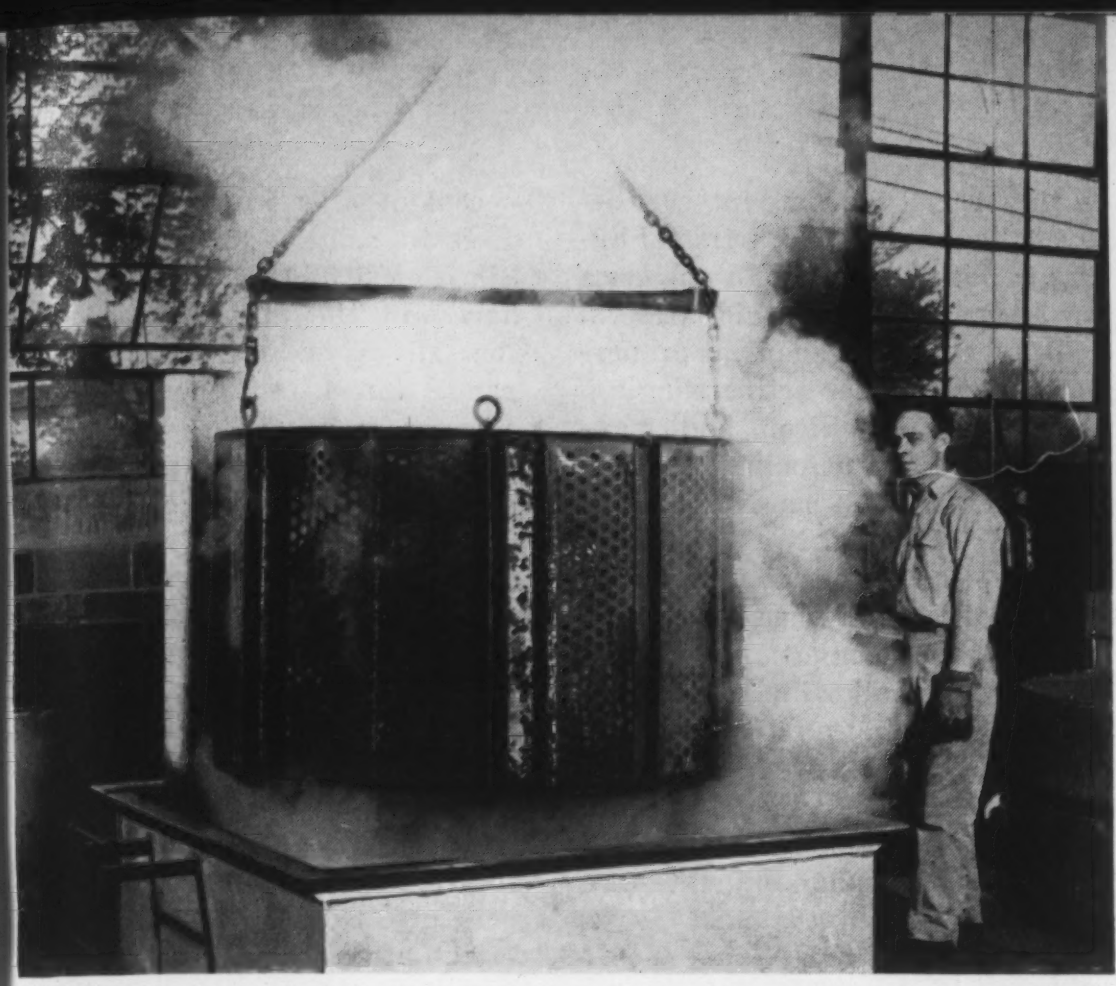
by B. L. Meredith, *Metallurgist, Central Research Laboratories, American Smelting and Refining Co.*

■ Aluminum castings are heat treated to develop a uniform structure, remove internal stresses, improve mechanical properties or improve dimensional stability. Usually, however, the principal objective is to improve mechanical properties.

If mechanical properties are to be altered by heat treatment, certain metallurgical characteristics are required. Of major importance are, 1) the composition must lie within a multi-phase region and, 2) a constituent of the alloy must be more soluble at high than at low temperatures. Under these conditions, a suitable combination of heat treating procedures will yield an alloy having substantially different mechanical properties from those found in the as-cast material.

Most common cast aluminum alloys are heat treatable. Some, however, are not appreciably improved by such treatment. These include No. 13 (12% silicon), No. 43 (5% silicon) and No. 214 (4% magnesium). Common alloys showing significant improvement include No. 220 (10% magnesium), No. 195 (4 copper, 1% silicon) and No. 355 (1 copper, 4 silicon, 0.5% magnesium).

To understand the principles of heat treatment it is necessary to be somewhat familiar with the mechanism of solidification in castings. Briefly, when an aluminum alloy starts to solidify, various crystals precipitate from the molten metal. The size, shape, nature and location of the crystals depend largely on the cooling rate at which the metal solidifies. Ordinarily a casting is composed of sections of varying thicknesses. Therefore, there may be considerable difference in structure due to the different cooling rates of these sections since a thin section will solidify more rapidly than a thick one.



Castings are quenched *after solution treatment to retain the homogeneous structure which is necessary to develop satisfactory properties during artificial aging.*

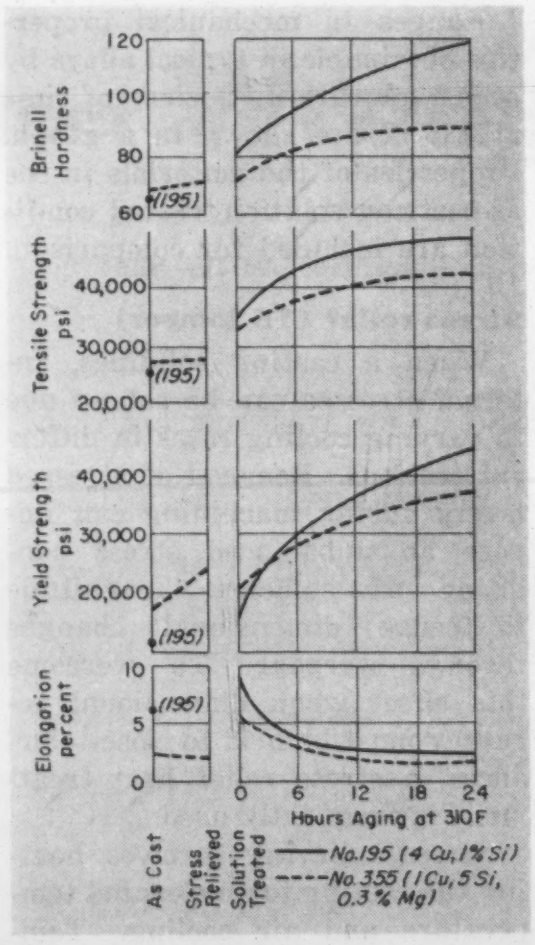
In an alloy containing constituents of varying solubility, the difference in cooling rate will cause a difference in the quantity remaining in solid solution from section to section. In a thin section which solidifies rapidly, more of the constituents will remain in solution than in a thick section. This is partially responsible for the variation in mechanical properties usually found in different sections of castings.

Heat treatments generally applied to aluminum casting alloys are designated as follows:

T4—Solution treatment
T6—Solution treatment followed by artificial aging
T5—Stabilizing or stress relieving
T7—Solution treatment followed by stabilizing

Temperatures specified for various heat treatments are critical and should be adhered to as closely as possible. Maximum permissible variation from the specified temperature should not be more than plus or minus 10 F. At high temperatures, a plus variation of more than 10 F may seriously damage castings while a similar minus variation may prevent achievement of proper results. At lower temperatures, variations from the specified value will lead to unsatisfactory results.

Treatment time, particularly in aging, is usually not precisely specified. It must be determined with test bars by trial and error. Specifications usually give a range, but even these ranges may be modified to obtain exactly the mechanical properties desired. The properties obtained by one particular combination of alloy, foundry and heat treatment will not necessarily be the same as those obtained with the same alloy by a different foundry and heat treating source.



Effect of artificial aging on mechanical properties.

Solution treatment (T4 temper)

Solution treatment is necessary to obtain a casting with a homogeneous structure. It is accomplished by heating the casting to a temperature high enough to redissolve most of the precipitated constitutents. This temperature varies with the chemical composition of the alloy. With the exception of No. 200 alloy which is solution treated at 820 F, the temperature range is 940-1000 F. At the solution temperature a casting has very low strength and can support only a little more than its own weight without undue distortion or sagging. Therefore, castings must be placed in suitably designed racks. They should not be stacked or otherwise loaded in the furnace in a haphazard manner.

Atomic mobility increases with temperature. Precipitated constituents are redissolved most satisfactorily at the highest temperature that will not harm the casting. The time required depends on the distance through which the atoms must travel and on the rate of diffusion, which varies with each solid solution.

A coarse structure requires longer solution treating time than a fine one. The time required for solution treating is also affected by section thickness of the casting and thermal conductivity of the alloy. It is important to allow enough time for the casting to reach a uniform temperature. In general, a period of 12 to 15 hr is sufficient to produce the necessary changes.

After the desired structural changes have occurred, no additional benefit is gained by further heating. However, it is necessary to retain the structure formed during solution treatment because the success of the artificial aging treatment depends on it. If the castings cool slowly, unfavorable precipitation occurs and the ben-

efits from solution treatment are reduced. Prompt chilling is therefore necessary. This can best be accomplished by immersing the casting in a cold medium like ice water. Since such a drastic temperature change might cause distortion or cracking, it is more practical to use boiling or near-boiling water for most alloys. In others, the precipitation reaction is so sluggish that they can be air-cooled.

At this heat treatment stage, the alloy is in an unstable condition. Its strength and hardness are usually higher than they were in the as-cast condition and most alloys are considerably more ductile. Structure and properties begin to change, however, within a period of 24 hr. Any straightening of the casting or correction for distortion is best carried out before this period has elapsed, while the metal is in a comparatively ductile condition.

Aging treatment (T6 temper)

Age hardening is possible because of the unstable solid-solution structure that was developed by solution treatment and subsequent quenching. Constituents which are less soluble at room temperature than at high temperatures begin to precipitate within a few hours after quenching, but several months may elapse before the changes are completed. Artificial aging is used to hasten this process, since precipitation occurs more rapidly at higher temperatures. Natural and artificial aging yield similar results, but an artificially-aged casting is ready for service sooner than a naturally-aged one.

Artificial aging is conducted at a much lower temperature than solution treating, usually at about 300 F. It is a function of time and temperature, so that the results can be controlled by varying either of these factors. The temperature should usually not be so high as to cause overaging because inferior mechanical properties will result. Occasionally, overaging is desirable, however, to obtain maximum dimensional stability and stress relief.

In general, the time interval between quenching and artificial aging is not important. In one class of alloys, however, this interval will affect the mechanical properties obtained after artificial aging. Alloys having silicon and magnesium as the principal alloying ingredients, such as No. 356 (7 Si, 0.3% Mg) and No. 355 (1 Cu, 5 Si, 0.3% Mg) are those affected by this interval. It has been found that higher elongations will be obtained by allowing 24 hr between quenching and aging treatments. The improved elongation values are accompanied by somewhat lower tensile and yield strengths. For maximum tensile and yield strengths and lower elongations, artificial aging should follow quenching promptly.

Structural changes produced by artificial aging are not normally detectable by the microscope, since the alloying constituents are precipitated in an extremely fine state. Aging effects are indicated by the changes in mechanical properties. These include an increase in strength and hardness, and a lowering of ductility and impact resistance as compared with that produced by solution treatment.

Ranges in mechanical properties obtainable in typical alloys by aging for varying periods of time at 310 F are shown in a graph. Properties of the materials in the as-cast and solution treated condition are included for comparison.

Stress relief (T5 temper)

When a casting solidifies, internal stresses can be set up due to varying cooling rates in different sections. Removal of stressed layers during machining can impose an unbalanced stress condition of sufficient magnitude to cause dimensional changes through warpage. To overcome this effect when dimensional accuracy must be held to close tolerances, a stress relief heat treatment is frequently used.

Stress relieving involves heating the casting to an elevated temperature and air cooling. Temperatures are generally held within the range 450 to 550 F —considerably lower than those used in solution heat treatment. Since most of the stresses are relieved in the first hour, holding the alloys in this temperature range for 4 to 5 hr is usually adequate. Extending the treatment time beyond this period is economically impractical because further reduction in stresses occurs at an extremely slow rate. In the relief of stresses, temperature is a much more significant factor than time. Where casting stresses are of a high magnitude or the alloy has an inherently low rate of stress relief, a satisfactorily low level of stress can be obtained by increasing the heat treatment temperature.

The stress-relief treatment also stabilizes the alloy by precipitating constituents which were retained in solution during cooling. Therefore, further dimensional changes will not occur at lower temperatures. The resulting mechanical properties are only slightly different from the as-cast properties. Strength, hardness and machinability are moderately improved and there is a corresponding reduction in ductility and impact resistance.

Stabilizing after solution treatment (T7 temper)

In addition to stresses arising from solidification of the casting, stresses may be induced in solution-treated parts by differential cooling rates during quenching. Depending upon the degree of control which can be exercised over the quenching operation, stresses can reach a high level. Aging treatments performed subsequent to solution treating are usually carried out near 300 F and little stress-relief is achieved. Where the casting application dictates a low stress level it may be necessary to age at a higher temperature at some expense in mechanical properties. This treatment is frequently called overaging.

Reference

R. A. Quadt, "Effect of Room Temperature Intervals Between Quenching and Aging of Aluminum Sand Cast Alloys", Trans. American Foundrymen's Assn., 1947, Vol 55, pp 351-355.

(Armco Steel Corp.)

How to Select Wrought Steels

by **John W. W. Sullivan,** *American Iron & Steel Institute*

This manual will show you how to select and make better and more economical use of rolled and forged steel products. It explains the factors and properties that must be considered when choosing a steel to meet the requirements of a particular application. And it gives in detail the properties of the following major steel groups:

- *Carbon Steels*
- *Alloy Steels*
- *Stainless and Heat Resisting Steels*

MATERIALS & METHODS MANUAL No. 117

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

JULY, 1955

■ This manual is intended to show how to make better and more economical use of wrought (rolled or forged) steel by presenting the factors involved in choosing a steel; explaining what steel is capable of doing; describing the effects of alloying elements in steel and citing the reasons for using several *kinds* of steel, such as carbon, alloy, high strength low alloy and stainless and heat resisting.

Choosing a steel for a product involves considerations of design, property evaluation, product performance, steel availability and cost. It has also involved the assumption that the product will be made of steel. Until verified, that assumption should be questioned in order to avoid overlooking other materials (metallic or nonmetallic).

Steel, as a large family of iron alloys, is widely used because it has property values, such as ranges of strength, hardness, ductility, toughness and other property values, which are unobtainable in other materials or are obtainable only at higher cost. Consequently, the problem of choosing a steel is basically one of property evaluation; and the choice of a particular steel follows the balancing of desired property values and product performance with cost.

Selection Factors

Design considerations

Thickness—If the product is not over ¾ in. at its thickest section, and there is no strength or toughness requirement for extreme temperature ranges and if corrosion resistance or unusual physical properties are not required, it is probable that the design can be based on carbon steel. The choice of grade or quality of the carbon steel is dependent upon its fabricating properties. For example, for many deep drawn products the ordered steel sections are only small fractions of an inch thick, and the needed mechanical properties are usually available in drawing quality carbon steel.

For much greater thickness ranges and moderate strength and ductility requirements, such as those of 12 to 20 in. forgings requiring minimum mechanical property values of 75,000 psi tensile strength, 37,500 psi yield strength, 20% elongation in 2 in. and 32% reduction of area, it is also probable that the design can be based on carbon steel, and the choice of grade controlled by the mechanical properties that can be developed by heat treatment.[1]

In the range of ¾ to 12 in., the design of many products can be based on carbon steel, the choice of grade being controlled by the more difficult to attain properties, fabricating or performance.

The ¾ in. limit is the author's estimate of thickness of carbon steel above which the decrease in tensile strength and yield point or yield strength can be so significant as to warrant consideration of alloy steel as the basis of design for products requiring high strength in performance. Concerning mass and thickness, Sisco[2] comments: "When steel section of large mass are quenched, the cooling rate decreases as the distance from the surface increases; as a consequence of this, the strength and hardness of the steel decreases progressively from the surface to the center but usually not linearly. . . . The tensile and yield strengths of low-carbon steels containing 0.12 to 0.20% carbon decrease as their size increases from 0.5 to 2 in.; the decrease in tensile strength with increasing section is greater with the higher carbon materials. The elongation and reduction of area apparently increase slightly with increasing section. . . . In the 0.40 to 0.50% carbon (1045) steel, quenched and tempered at 540 and 650 C (1000 and 1200 F), the tensile and yield strengths decrease markedly and the reduction of area decreases slightly with increasing section size. The elongation increases."

It is the author's opinion that there are more than 200,000 identified steel products. A significant number of them, such as flat rolled electrical steels, alloy steel ball and roller bearing wires and many others, are not made from carbon steel, regardless of section thickness, because the desired properties have not been developed in carbon steels.

Weight Saving—For some products, detailed examination of weight suggests a steel other than carbon steel as the basis of design. Three important aspects of product weight saving are: 1) decrease in product size and components associated with it; 2) increase in pay load resulting from decrease in product weight; and 3) savings in freight cost.

Expected Life of the product may involve resistance to wear or

How to Choose a Steel

The following step-by-step guide is offered to assist you in choosing a wrought steel for a particular product.

1. Review the design for excess metal, stress raisers, unnecessarily close tolerances and unneeded requirements such as condition, finish, quality, property value or chemical composition range or limit.
2. Ascertain the most needed properties for product performance.
3. Ascertain the most needed properties for fabrication.
4. Ascertain the cost of obtaining the most needed properties.
5. If the most needed properties are available in more than one kind of steel or more than one grade, type, condition or quality, final selection may be based on such factors as cost, availability, delivery and customer service.
6. For detailed information, consult the steel producers.

corrosion, mechanical properties at sub-zero or elevated temperatures, cost of replacing the failed product and expense of interrupting production following product failure. Any of those considerations may rule out carbon steel as the design basis.

Fabrication — Machinability, weldability or deforming characteristics can be one of the controlling factors in determining the kind of steel to be used.

Stress Concentration—For some product uses, stress concentration caused by a sharp change of cross section, hole, or other discontinuity is an important design consideration because all steels are not equally tough or plastic: some yield or flow under localized stressing rather than break. The choice of steel can be simplified by modifying the design to eliminate or reduce stress concentration.

Cost—Cost should be estimated in each of the foregoing considerations before the kind of steel is selected for design purposes. These estimates can control the selection of both kind and grade of steel, particularly if two or more kinds are suitable.

Most needed properties

After the design is established, the choice of a steel is further determined by the most essential properties for product performance, then by the properties for product fabrication, and finally availability and cost.

The most needed property of a door hinge for a barn or home is strength; the most important requisite for fabrication is ductility. Low-carbon hot rolled carbon steel strip has adequate ductility for hinge fabrication and sufficient strength for hinge performance. However, other factors such as pin fit and appearance usually dictate the selection of another condition, such as cold rolled. Cold rolled carbon steel strip, No. 2 (half hard) temper, enables the barrels or curls of a matched pair of hinges to be formed so that the pin fit is tight and remains tight in use. The smooth surface of cold rolled strip and the smoothly slit edges are attractive to the home owner. Also, cold rolled strip has higher yield strength so that the hinges can be made thinner (down to 0.123 in. for the 3½ in. butt hinge on interior doors): a significant factor to the hinge manufacturer.

The most needed property for road scraper blades is wear resistance. Materials to be scraped, such as silica sand, conglomerate sand and clay, have different abrading characteristics; and consideration is given to these characteristics in selecting the kind of steel and grade. High carbon steel, grade 1084, is a popular choice. Other desirable characteristics, such as strength and fabrication can be obtained in the high carbon steels, and they are available in needed sizes. However, 1090, 1062, 1061 in carbon steel and high strength low alloy steel are, or have been, used for the blades.

Check List of Properties—Table 1 is a suggested check list to be reviewed for properties needed in any given application. The list includes some of the properties of steel frequently needed for steel fabrication and product performance, and also some less frequently required but occasionally overlooked properties. The separation of properties according to performance and fabrication is not intended to be mutually exclusive: the properties of the end product must be in the steel to be fabricated or be capable of development during fabrication.

It is the author's observation that the problem of choosing a steel is more than 50% solved when the most essential properties for fabrication and performance are conclusively established. Usually, the remainder of the problem is more a matter of economics than technology.

Only a few of the properties in Table 1 are generally required for a particular product. However, when one grade or type of steel is being considered as a replacement for another, it is advisable to consider the entire list of properties because of differences in property values among steels. For example, the choice of Type No. 316 stainless steel to replace Type No. 430 in a disk operating at elevated temperatures required reconsideration of dimensional tolerances of the disk and its holder because the difference in

TABLE 1—CHECK LIST OF SOME PROPERTIES OF STEEL

FOR PERFORMANCE OF PRODUCT
Static strength: tension; shear; torsion
Impact strength: tension
Creep strength
Endurance ("fatigue") limit
Yield point
Yield strength (for steels not having yield point characteristics)
Ductility; elongation; reduction of area
Stiffness (ratio of yield point or yield strength to tensile strength)
Residual stress
Hardness: resistance to indentation, abrasion; retention of cutting edge
Corrosion resistance
Heat resistance: scaling; loss of strength, ductility
Surface: appearance, smoothness; ease of cleaning, sterilizing; paint retention
Thermal: expansion; conductivity
Electrical resistivity
Magnetic permeability
Aging characteristics: change of mechanical property values, dimensions
Galling resistance
Seizing resistance
Catalytic effects

FOR FABRICATION OF PRODUCT
Surface, as it affects: hot working, cold working, cold finishing, plating, coating, painting
Forming characteristics: hot working and cold working, including forging, rolling, drawing, extruding, spinning, bending, stamping, punching
Machinability
Weldability
Hardenability
Grain size
Response to heat treatment: deforming; cracking

Note 1. Modulus of elasticity and density are not listed because they vary only slightly among carbon steels, constructional alloy steels and high strength low alloy steels; significant variations occur in highly alloyed materials, such as some stainless and heat resisting steels, tool steels and superalloys.

Note 2. "Temper" is not listed because it is not defined in numerically measurable units. As applied to steel, temper is related to indentation hardness, elasticity and stiffness. However, "Temper Numbers" and "Tempers," associated with indentation hardness, are sometimes used to describe combinations of property values and property ratios of sheets, strip, tin plate, terne plate and black plate.

Note 3. Table 1 is not intended to cover tool and die steels. Significant properties of those steels include: hardness; depth of hardening; distortion in hardening; freedom from cracking during hardening; toughness; resistance to (a) decarburization, (b) softening effects of heat and (c) wear.

thermal expansion was overlooked. The 316 disk buckled during its first trial. For the 32 to 600 F range, the mean coefficient of linear expansion of No. 316 is 48% greater than that of No. 430.

What Grain Size Means

Grain size, listed in Table 2, means the austenitic grain size. It is usually determined by the McQuaid-Ehn test or others as described in an ASTM standard.[14] No. 1 grain size is the coarsest and contains up to 1½ grains per sq in. of area at 100 dia magnification.

It is impractical to control austenitic grain size within narrow limits; therefore, killed steels are specified either as fine grain (5 to 8, incl.) or coarse grain (1 to 5, incl.). All grains cannot be sectioned through their maximum dimension. When grain size No. 5 overlaps with other numbers, the grain size is readily determined because it is practically impossible to produce steel which is uniformly No. 5.

Grain size can affect several properties of the product as well as the fabrication of the product. Experience indicates the following comparative effects of grain size.

Fine grain steels have less tendency to warp in quenching, are tougher (have higher notched bar sensitivity values at considerably lower temperature), develop better core properties, are less susceptible to hardening cracks and grinding cracks and are more ductile, than coarse grain steels.[6]

Coarse grain steels harden more deeply, machine faster, carburize more rapidly, are less susceptible to soft spots, have better plastic properties and are stronger, than fine grain steels.[6]

Practically all alloy steels and all high-carbon carbon steels are produced as fine grain in the United States. Most resulfurized carbon steels are made as coarse grain to obtain faster machining.

Strength and Ductility — For many products, strength and ductility are the primary requirements. Typical strength and ductility levels of some of the standard grades of hot rolled carbon steel bars are shown in Table 2. Where moderate strength and ductility are needed, the choice of a hot rolled steel might be the most economical, such as 1020 grade for lawn mower frames, bicycle forks and gas pump pinions. If other properties also are required, such as dimensional accuracy and higher yield strength, the cold rolled 1020 grade may be the economical choice for shafts, tie rods and studs. Additional property requirements might also include a hard surface with moderate core toughness, in which case the cold drawn and carburized 1020 grade may be preferred for spindles, piston pins and rollers.

The strength and ductility values shown in Table 2 are estimated minima for the size range and test specimen described. These and other property values of steels are actually points or zones on distribution curves of property values, because the factors responsible for strength and ductility vary even in a particular grade of steel. For example, the strengthening elements in 1020 are carbon, manganese and phosphorus, plus any silicon remaining from deoxidation and the incidental elements in the steel. Carbon can vary from 0.18 to 0.23% on ladle analysis and 0.16 to 0.23 or 0.18 to 0.25% on check analysis; manganese from 0.30 to 0.60 on ladle analysis and 0.27 to 0.60 or 0.30 to 0.63% on check analysis; and phosphorus up to 0.040 on ladle analysis and up to 0.048 on check analysis.

Hot rolled thickness, tempera-

TABLE 2—HOT ROLLED CARBON STEEL BARS
ESTIMATED MINIMUM VALUES OF STRENGTH, DUCTILITY AND HARDNESS

(For sizes ¾ to 1¼ in. based on standard round tension specimen with 2-in. gage length)

SAE or AISI No.	Ten Str, psi	Yield Str, psi	Elong in 2 in., %	Red of Area, %	Brinell Hard
Hot Rolled Basic Open Hearth Carbon Steel Bars.					
1008	44,000	24,500	30	55	86
1010	47,000	26,000	28	50	95
1015	50,000	27,500	28	50	101
1018	58,000	32,000	25	50	116
1020	55,000	30,000	25	50	111
1022	62,000	34,000	23	47	121
1025	58,000	32,000	25	50	116
1030	68,000	37,500	20	42	137
1035	72,000	39,500	18	40	143
1040	76,000	42,000	18	40	149
1045	82,000	45,000	16	40	163
1050	90,000	49,500	15	35	179
1055	94,000	51,500	12	30	192
1060	98,000	54,000	12	30	201
1070	102,000	56,000	12	30	212
1080	112,000	61,500	10	25	229
1095	120,000	66,000	10	25	248
Hot Rolled Acid Bessemer Resulfurized Carbon Steel Bars					
1111	60,000	33,000	25	45	121
1112	61,000	33,500	25	45	121
Hot Rolled Basic Open Hearth Resulfurized Carbon Steel Bars					
1109	50,000	27,500	30	50	101
1115	55,000	30,000	25	50	111
1117	62,000	34,000	23	47	121
1137	88,000	48,000	15	35	179
1140	79,000	43,500	16	40	156
1141	94,000	51,500	15	35	187
1144	97,000	53,000	15	35	197

**Grades over 1050 generally are heat treated.*

ture at which rolling was completed and the rate of cooling after hot rolling also affect strength and ductility. Table 3 shows the effect of plate thickness on strength for carbon steel of 0.20-0.30% carbon. Table 4 shows the variation in carbon content and plate thickness to maintain tensile strength in the range of 55,000 to 65,000 psi.

Strength and ductility are affected also by heat treatment and cold working. For one inch sections of C1020 ("C" designates basic open hearth), the effect of heating at 1575-1625 F, water quenching and tempering at 200-1300 F on strength, ductility and hardness is shown in Table 5. Expected minimum mechanical property values of cold drawn carbon steel in rounds, squares and hexagons, as cold drawn, cold drawn followed by low temperature stress relief and cold drawn followed by high temperature stress relief, for four popular grades, are shown in Table 6.

Data from extensive testing indicate that the factors which affect strength and ductility can produce wide variation in values

TABLE 3—CARBON STEEL PLATES[3] RELATION OF THICKNESS TO STRENGTH

(For carbon content of 0.20-0.30%)

Plate Thick, in.	Ten Str, psi	Yield Str, psi
¼	68,000	47,000
½	65,000	42,500
1	62,000	39,500
1½	60,000	38,500
2	59,000	38,000

(T. M. Jasper and C. W. Wheatley)

TABLE 4—CARBON STEEL PLATES[3] RELATION OF CARBON AND PLATE THICKNESS

(For 55,000-65,000 psi tensile strength)

Plate Thick, in.	Carbon, %
¼	0.16–0.18
1	0.22–0.25
2	0.25–0.28

(C. H. Herty, Jr.)

TABLE 5—C1020 CARBON STEEL 1-IN. SECTIONS[3] EFFECT OF HEATING AT 1575-1625 F, WATER QUENCHING AND TEMPERING AT 200-1300 F ON STRENGTH, DUCTILITY, AND HARDNESS

Temper. Temp, F	Ten Str, 1000 psi	Yield Str, 1000 psi	Elong in 2 in., %	Red of Area, %	Brinell Hard
200	104	80	10	35	216
300	104	80	11	40	216
400	103	80	12	44	210
500	102	79	13	48	207
600	100	77	14	52	203
700	98	75	16	55	197
800	96	72	18	58	190
900	93	67	20	62	183
1000	90	62	23	64	175
1100	86	56	26	67	164
1200	79	47	29	69	153
1300	70	35	33	70	138

(The International Nickel Co., Inc.)

TABLE 6—PROPERTIES OF COLD DRAWN CARBON STEEL BARS: ROUNDS, SQUARES, HEXAGONS

(Expected minimum values of tensile strength in 1000 psi, yield strength in 1000 psi, % elongation in 2 in., % reduction of area and Brinell hardness number)

Grade and Size, in.	As Cold Drawn					As Cold Drawn Followed by Low Temp Stress Relief					As Cold Drawn Followed by High Temp Stress Relief				
	TS	YS	El	RA	BHN	TS	YS	El	RA	BHN	TS	YS	El	RA	BHN
C1018															
⅝ to ⅞, incl	70	60	18	40	143	—	—	—	—	—	65	45	20	45	131
Over ⅞ to 1¼, incl	65	55	16	40	131	—	—	—	—	—	60	45	20	45	121
Over 1¼ to 2, incl	60	50	15	35	121	—	—	—	—	—	55	45	16	40	111
Over 2 to 3, incl	55	45	15	35	111	—	—	—	—	—	50	40	15	40	101
C1045															
⅝ to ⅞, incl	95	85	12	35	187	100	90	12	35	197	90	70	15	45	179
Over ⅞ to 1¼, incl	90	80	11	30	179	95	85	11	30	187	85	70	15	45	170
Over 1¼ to 2, incl	85	75	10	30	170	90	80	10	30	179	80	65	15	40	163
Over 2 to 3, incl	80	70	10	30	163	85	75	10	25	170	75	60	12	35	149
C1117															
⅝ to ⅞, incl	75	65	15	40	149	80	70	15	40	163	70	50	18	45	143
Over ⅞ to 1¼, incl	70	60	15	40	143	75	65	15	40	149	65	50	16	45	131
Over 1¼ to 2, incl	65	55	13	35	131	70	60	13	35	143	60	50	15	40	121
Over 2 to 3, incl	60	50	12	30	121	65	55	12	35	131	55	45	15	40	111
C1137															
⅝ to ⅞, incl	100	90	11	35	197	105	95	11	35	212	95	75	15	45	187
Over ⅞ to 1¼, incl	95	85	11	30	187	100	90	11	30	197	90	75	15	40	179
Over 1¼ to 2, incl	95	80	10	30	179	95	85	10	30	187	85	70	15	40	170
Over 2 to 3, incl	85	75	10	30	170	90	80	10	25	179	80	65	12	35	163

Note: Values in above table are not applicable to turned and polished or turned and ground bars; they have mechanical property values corresponding to those of hot rolled steel bars of the same grade and size.

of those properties. For example, for a grade expected to have a tensile strength of 100,000 psi, test values may run to as much as 10,000 to 15,000 psi above it.[3] Hoyt[3] states that, "A study of a large number of data for a given steel shows that the properties may vary from a mean value about as follows: T.S. ± 10,000-15,000 psi; Y.S. ± 10,000-15,000 psi; Elong. ± 2-5% and R.A. ± 2-5%."

In choosing a steel, the significance of variation of property values is this: If there is a need for a maximum, minimum, or range of a property value, that information should be given to the steel producer. With that information in advance of production, he can use manufacturing controls, testing and selection of steel to assure that the steel meets the specified values. However, for many products, variation in the foregoing mechanical property values does not significantly affect the fabrication or performance of the product.

The range of properties available in steels is evident when one considers the capabilities of several kinds of steel comprising the bulk of steel production. These steels are described later in the following order: carbon, alloy, high strength low alloy and stainless and heat resisting.

Fabricating Properties

Machinability

Objectives sought in machining steel include high cutting speed, long tool life, low cutting temperature, low power consumption, appropriate surface finish, well broken chips, control of tolerance and freedom from corrosion by the cutting fluid.[9]

When machinability is an important fabrication requirement, consideration must be given to the variables involved: steel; machine tool; cutting speed, feed and depth of cut; cutting tool; cutting fluid; and operator of the machine tool. Steel is only one of the eight variables. Its machinability depends on chemical composition, condition, grain size and metallographic structure.[10]

Some elements, such as sulfur, phosphorus, lead and selenium are added to some steels to improve machinability by forming inclusions which break up chip continuity, reduce tool friction or retard build-up of metal on the cutting tool. Other elements affect machinability to the extent that they toughen or strengthen steel or influence the grain size or metallographic structure.

Steel may be in the following condition: hot rolled; forged, normalized, annealed, quenched and tempered; or cold worked (drawn or rolled) with or without subsequent thermal treatment (to restore ductility or relieve stress).

Sometimes the condition of steel is a controlling factor in over-all economy or machining, especially when a choice can be made between the hot rolled and cold worked conditions. Cold working increases strength and decreases ductility: low ductility favors machinability. A general comparison follows.

For steels containing 0.30% carbon or less, cold rolled bars have better machinability than hot rolled bars. For steels containing from 0.30 to 0.40% carbon, there is little difference in machinability between cold rolled and hot rolled bars. (For alloy steels containing 0.30% carbon or over, annealing prior to machining is recommended.) For steels containing over 0.40% carbon, machinability of hot rolled steel is superior to that of the cold rolled or cold drawn steel. (For carbon steels containing 0.40% carbon or over, annealing prior to machining is recommended.)[9]

The large structural grain size usually improves machinability, but not necessarily in proportion to the grain size; fine grain steels, made, usually, by additions of aluminum, are generally of poorer machinability. The precise effects of grain size on machinability have not been established.

Lamellar pearlite, in moderate amounts, is considered to be the most favorable structure in which carbon occurs in steel for free machining.[11] When too much pearlite is present, as in very high carbon steels, its strengthening effect retards machining, and spheroidizing is recommended. Other heat treatments are used to improve machinability: for carbon steels containing less than 0.10% carbon, heating to above the transformation temperature range followed by quenching in water to lower the ductility; for medium carbon steels, heating to coarsen the grain and break up the continuity of the ferrite; for alloy steels containing carbide forming elements, heating to produce discontinuous coarse grained lamellar pearlite.[11]

Table 8 shows machinability ratings for steels machined under the particular set of conditions stated in the table. As with tests in general, those ratings are essentially guides rather than strict comparisons. The hardness ranges shown in Table 8 also are guides.

Indentation hardness is not a selective indicator of machinability because the indenter of the hardness measuring instrument work hardens the steel by slow compression, whereas the cutting tool of a machine work hardens by rapid shear. The hardness instrument does not measure the steel's response to the work hardening effect of the machining action.[12] However, hardness ranges are sometimes associated with machinability ratings as a matter of information. It has been reported that the generally accepted limiting value of hardness for normal machining of ferrous materials is about 355 Brinell, although many steels have been machined in mass production at a hardness of 400 Brinell and higher.[9]

Similarly, tensile strength is

not a selective indicator of machinability. Although shear is involved in both tensile testing and cutting steel, in the former the shear is developed in tension, but in the latter it is developed in compression.[12] Furthermore, the tensile test is essentially static, while the cutting action is dynamic; and the rapid application of force in cutting is not comparable to the slow application of stress in tensile testing.

TABLE 7—MACHINABILITY RATINGS OF STEEL[9]

(Machined by high speed steel tools with suitable cutting fluid at 180 ft per min under norma cutting conditions. Each steel is rated to nearest 5%, based on 100% rating of AISI B1112 in cold rolled or cold drawn condition)

AISI No.	Condition	Rating, %	Brinell Range
C1010	CD[a]	50	131–170
C1016	CD	70	137–174
C1020	CD	65	137–174
C1022	CD	70	159–192
C1030	CD	65	170–212
C1035	CD	65	174–217
C1040	MA[b]	60	179–229
C1045	MA	60	179–229
C1050	MA	50	179–229
C1070	MA	45	183–241
B1111	CD	95	179–229
B1112	CD	100	179–229
B1113	CD	135	179–229
C1115	CD	85	143–179
C1117	CD	85	143–179
C1118	CD	80	143–179
C1120	CD	80	143–179
C1137	CD	70	187–229
C1330	MA	50	179–235
C1335	MA	50	187–241
C1340	MA	45	187–241
2515	MA	30	170–229
3140	MA	55	187–229
E3310	MA	40	170–229
4023	CD	70	156–207
4037	MA	65	179–229
4047	MA	55	183–235
4130	MA	65	187–229
4137	MA	60	187–229
4150	MA	50	187–235
4320	CD	55	197–228
4340	MA	45	187–241
4615	CD	65	174–217
4640	MA	55	187–235
4815	CD	50	187–229
5120	CD	65	170–212
5140	MA	60	174–229
5150	MA	55	179–235
E52100	S[c]	30	183–229
6120	CD	50	179–217
6145	MA	50	179–235
6150	S	45	183–241
8620	CD	60	170–217
8630	MA	65	179–229
8645	MA	55	183–235
8650	MA	50	183–241
8720	CD	60	170–217
8740	MA	60	179–229
8750	MA	50	183–241
9260	MA	45	187–255

[a] *CD: Cold drawn condition.*
[b] *MA: Mill annealed condition.*
[c] *S: Spheroidized condition.*
The following machinability ratings, based on B1112 as 100%, have been reported also; B1111, 94%; C1211, 94%; B1112, 100%; C1212, 100%; B1113, 136%; C1213, 136%.[27]

Weldability

In the welding of steel there are three main sources of variability which can significantly affect the properties of the welded product: variations in the steel; variations in the welding equipment and process; variations in the performance of the welding operator. It is the author's opinion that the third source of variability is the one most frequently overlooked in the choice of a steel to be welded.

In view of existing opinions on "weldability," only the following general comments are presented. Stout and Doty[13] differentiate two aspects of weldability as follows. "For use in a working definition of weldability the authors have chosen the terms 'joinability' and 'performance' to express weldability in fabrication and weldability in service, respectively. The weldability of a steel is defined as the ease with which the required degree of joinability and performance can be obtained with a given welding process and procedure. Accordingly, the joinability of a steel when welded is defined as the degree of soundness of that steel and accompanying weld metal when joined by a given welding process and procedure, and the performance of a steel when welded is defined as the mechanical behavior of that steel after subjecting it to a given welding process and procedure, relative to its behavior in the unwelded condition."

Despite the difficulty of defining weldability and of developing simple numerical measures of that "property," significant experience in welding steel has been accumulated. Part of that experience is reported by Stout and Doty[13] in this manner: "The great tonnage of steel used for welded applications consists of low-carbon steel (0.30% carbon and less). The remaining tonnage is made up of higher-carbon steels and various alloy steels. Practical experience over the years has proved that not all of these steels can be welded with the same degree of ease. For example, low-carbon steel having less than 0.15% carbon can be easily welded by nearly all of the welding processes and the resultant welds are generally of high quality. Mild steel (low-carbon steel containing 0.15-0.30% carbon) can be readily welded by most of the welding processes provided the section thickness at the point of welding is not greater than about ½ in. The welding of somewhat thicker sections of this steel may or may not require extra caution. The dividing line is not sharp. Moreover, the welding of very thick sections of mild steel often requires more than a minimum

amount of care or control to obtain a high quality joint. The degree of precaution necessary to obtain good quality joints in higher-carbon (over 0.30%) steels and in alloy steels varies widely. Most of these steels are considerably more difficult to weld than mild steel. However, some stainless steels and some low-carbon low-alloy steels are readily weldable."

Carbon Steels

The extensive product application of carbon steels is indicated by the preponderant tonnage of these steels used every year. For example, of the 63,153,000 tons of steel shipped in 1954 by United States producers, 58,935,000 tons or 93% were carbon steels. Some specific applications for some of the carbon steel grades are shown in Table 7.

While all steels contain carbon, steel is considered to be carbon steel 1) when no minimum content is specified or required for aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, tantalum, titanium, tungsten, vanadium or zirconium, or any other element is added to obtain a desired alloying effect; 2) when the specified minimum for copper does not exceed 0.40%; or 3) when the maximum content specified for any of the following elements does not exceed the percentages noted: manganese 1.65, silicon 0.60, copper 0.60.

TABLE 8—USES OF SOME STANDARD GRADES OF BASIC OPEN HEARTH CARBON
(Steel bars ordered in hot rolled condition*)

Grade	Use	Grade	Use
1010	Bracket, tire	1040	Axle, trailer
	Chain, electric welded		Clamp, wire rope
	Frame, bed spring		Nut, lock
	Handle, bumper jack		Wrench, hex socket
1015	Bench, park	1045	Axle, mine dump car
	Bolt, hot headed, cut thread		Hammer, fender repair
	Bolt, hot headed, roll thread		Mold, rubber
	Frame, window		Nut, hot pressed
1020	Fork, bicycle	1050	Driver, screw
	Frame, lawn mower		Hoe
	Hook, meat		Pliers
	Pinion, gas pump		Shaft, armature
1025	Fitting, pipe	1060	Ball, cement crusher
	Pedal, brake		Bar, crow
	Pedal, clutch		Chisel
	Shoe, brake		Rail, bed side
1030	Fork, gear shift	1080	Axe, single edge
	Key stock		Cutter, chain
	Shoe, tractor		Hammer, ball peen
	Socket, cable		Point, cultivator
1035	Axle, toy wagon	1095	Bit, mining machine
	Bar, furnace tapping		Knife, lawn mower bed plate
	Handle, wrench ratchet		Link, chain, potato digger
	Roll, tinning		Shim

**Hot rolled carbon steel bars are ordered also in the following conditions: pickled, annealed, normalized, stress relieved or heat treated (such as heated, quenched in water, oil or air, and tempered, to improve grain structure or mechanical properties).*

Carbon steel grades are generally identified by ranges or limits of percentages for carbon, manganese, phosphorus and sulfur. The steels may contain significant amounts of silicon if that element is specified or required by the deoxidation practice, or copper if that element is specified to increase atmospheric corrosion resistance. In addition, the steels may contain amounts of elements (including silicon and copper) which come from the scrap and other materials used in steelmaking. The free machining carbon steels contain significant amounts of sulfur, phosphorus or lead or combinations of those elements.

The properties of carbon steel are due mainly to the inherent strength and ductility of iron, as it is modified principally by carbon and to a lesser extent by other elements which are intentionally or unavoidably present in the resulting alloy, namely, steel. Additional property development results from: 1) iron's ability to dissolve carbon at elevated temperatures and reject nearly all of the carbon at lower temperatures; 2) the solubility of other elements in iron; and 3) the strengthening effect of cold working.

As the carbon content of carbon steel is increased, strength increases and ductility decreases. The carbon steels shown in Table 2 generally indicate the increase in estimated minimum tensile strength of hot rolled bars in sizes of ¾ to 1¼ in. of 44,000

Types of Steel[7]

In most steelmaking processes the principal reaction is the combination of carbon and oxygen to form a gas. If the oxygen available for that reaction is not removed prior to or during casting (by addition of silicon or other deoxidizer), gas continues to evolve during solidification. Proper control of the amount of gas evolved determines the type of steel. If practically no gas is evolved, the steel is termed "killed" because it lies quietly in the molds. Increasing degrees of gas evolution result in semikilled, capped or rimmed steels.

Killed Steels are characterized by a more uniform chemical composition as compared to other types; however, there are some variations in composition from surface to center and from top to bottom of the ingot. From killed steels there is only a slight evolution of gas during solidification of the metal after pouring into molds. A shrinkage cavity (known as primary pipe) forms in the upper portion of the ingot, and that cavity is normally eliminated by discarding.

Killed steels are produced by various steelmaking practices involving the use of deoxidizing elements which act with varying intensities. The most common deoxidizing elements are silicon and aluminum. Due to the variation in deoxidation practices in manufacturing killed steels, the choice and amounts of specific deoxidizers to be used, either singly or in combination, are normally left to the discretion of producers.

Because of greater uniformity in chemical composition and properties, killed steels are used for forging, carburizing and heat treating applications.

Semikilled Steels have variable degrees of uniformity in composition and have properties intermediate between those of killed and rimmed steels. Semikilled steels are used in skelp, plates, structural sections[6] and galvanized sheets and strip.[8]

Capped Steels have properties similar to those of rimmed steels but to a degree intermediate between those of rimmed and semikilled steels. A deoxidizer may be added to effect a controlled rimming action when the steel is cast. The gas entrapped during solidification is in excess of that needed to counteract normal shrinkage, resulting in a tendency for the steel to rise in the mold. The capping operation limits the time of gas evolution and prevents the formation of an excessive number of gas voids within the ingot. Capped steel is generally cast in bottle top molds using a heavy metal cap.

The resulting "mechanically capped" steel has most of the surface qualities of rimmed steel and is more uniform in hardness throughout the cross section of rolled products.[8] Capped steel is advantageously used for tin plate where a controlled degree of uniform stiffness is desirable in the end product. Capped steel is used also in some galvanized sheet products.[8]

Capped steel can be cast also in open top molds, substituting an addition of aluminum or ferrosilicon for the metal cap, on the top of the molten steel, to cause the steel on the surface to lie quietly and solidify rapidly.

Rimmed Steels have marked differences in chemical composition across the section and from top to bottom of the ingot. They have an outer rim that is lower in carbon, phosphorus and sulfur than the average composition of the whole ingot, and an inner portion, or core, that is higher than the average of those elements. The typical structure of the rimmed steel ingot results from a marked gas evolution during solidification of the outer rim.

During solidification of the rim, the concentration of certain elements increases in the liquid portion of the ingot. During solidification of the core, there is some increase in segregation in the upper and central portions of the ingot.

Normally the carbon content of rimmed steels is less than 0.25% and the manganese content is less than 0.60%. Satisfactorily rimmed steels do not retain any significant percentages of highly oxidizable elements such as aluminum, silicon or titanium. The structural pattern of the ingot persists through the rolling process to the final product.

The structural, surface and other characteristics of rimmed steels are used in the manufacture of products involving cold bending, cold forming or cold heading. Rimmed steels are used for some plate, sheet, strip, tin plate[8] and wire products.

Ed. Note—"Type" is used also to identify chemical composition, as in the type numbers for stainless and heat resisting steels.

psi for grade 1008 (0.10% max C, 0.25-0.40% min) to 120,000 psi for grade 1095 (0.90-1.03% C, 0.30-0.50% min). For the same steels the ductility factors decrease from 30 to 10% elongation in 2 in. and from 55 to 25% reduction of area of the test specimen.[4]

Effect of elements in carbon steel

The strengthening effect of carbon varies with increasing carbon content: In the as-rolled condition the tensile strength of carbon steel increases about 880 psi per 0.01% increase in carbon at the 0.20% C level, about 1040 psi at 0.40% C and about 1200 psi at 0.60% C.[5] A rise in carbon content increases the hardness of carbon steels in the as-rolled, normalized and heat treated conditions.

Carbon affects other properties, such as machinability and weldability, which are considered

later; these properties also are affected by the metallographic structure, grain size and presence of other elements.

The increase in tensile strength and hardness accompanying the increase of carbon content for the steels in Table 2 is due partly to phosphorus and manganese: Phosphorus increases strength and hardness to about the same degree as carbon, and manganese to a lesser degree. Manganese is intentionally present in every steel for at least one reason: to combine with sulfur and thereby enable the steel to be hot worked. Manganese is used also to improve the surface (except that of rimmed steels of extremely low carbon content) and to increase the rate of carbon penetration during carburizing. Increasing the manganese content decreases the ductility to a lesser extent than carbon. Phosphorus also aids machinability, decreases ductility and improves resistance to atmospheric corrosion particularly in the presence of copper. It increases wear resistance and electrical resistivity.

Phosphorus in excess of 0.08% makes carbon steels cold short or brittle because it tends to cause coarse grain structure and segregation. Copper and chromium increase tolerance for phosphorus, and phosphorus is a significant element in many high tensile steels which exhibit toughness.[6]

Sulfur is beneficial to steel only in improving machinability. Increasing the sulfur content of steel decreases ductility, toughness, weldability and surface quality.

Copper is present in nearly all carbon steels, coming largely from the scrap used in steelmaking. It is not removed by any of the conventional steelmaking processes. Sometimes carbon steels are specified to contain a minimum of 0.20% copper to improve atmospheric corrosion resistance. Copper is detrimental to surface quality and, in appreciable amounts, is also detrimental to hot working operations. It affects forge welding adversely but does not seriously affect arc or acetylene welding. The amounts of copper ordinarily in carbon steels have no significant effect on mechanical properties.

Alloy Steels

A particular steel is used for a specific product because it provides property values for the product which are not obtainable in any other steel, or because the one selected is more economical in product fabrication or product performance. Alloy steel is used for either reason. Property values are developed by elements (including carbon, manganese and silicon, and sometimes phosphorus or sulfur) which are retained from raw materials and by additions of these and other elements during steelmaking, in conjunction with appropriate steel manufacturing practices. Some of the effects of the elements are described briefly in Table 9.

In manufacturing alloy steels, elements are used to refine the steel, to develop property values, or both. Deoxidizers such as silicon and aluminum, for example, combine with unwanted oxygen. Manganese combines with sulfur to form a solid compound that is plastic at hot working temperatures. Titanium, for example, is used to aid the removal of unwanted elements by forming compounds which enter the slag. Elements so used are called scavengers. Silicon, aluminum, manganese and titanium confer other benefits to steel, as mentioned in Table 9.

Some elements, such as aluminum, nickel, phosphorus and silicon, dissolve to some extent in iron, but do not form carbides. Others, such as titanium, vanadium, tungsten, molybdenum, manganese and chromium, combine with carbon to form carbides and is also partially dissolved in iron.

The effects of the carbides on property values of steel vary significantly, depending upon the kind, amount, size, shape and distribution of the carbide particles. The effects of the dissolved elements vary with the element, amount dissolved and the solubility of the element in the high temperature form of iron (gam-

All steel mill products *are carefully tested to maintain close control and high quality.*

ma iron) and room temperature form (alpha iron). In addition, the presence of two or more elements, such as chromium, nickel and molybdenum intensifies their effects on properties, such as strength and hardness, to a greater extent than the sum of the individual effects of the elements. That intensifying effect is the basis of the N. E. (National Emergency) Steels developed in World War II and of other steels.

TABLE 9—SOME EFFECTS OF ELEMENTS IN STEEL [7, 8, 28, 29, 30]

Element	Effects
Aluminum	Deoxidizes; restricts grain growth; aids surface hardness in nitriding
Boron	Increases hardenability, the increase being greater at lower carbon levels
Carbon	Increases strength and hardness; decreases ductility
Chromium	Increases hardenability, strength at room and elevated temperatures, resistance to corrosion, oxidation and abrasion
Cobalt	Holds cutting edge at elevated temperature; increases hardness
Columbium	Inhibits intergranular corrosion in high chromium and chromium-nickel stainless and heat resisting steels
Copper	Increases corrosion resistance and strength
Lead	Increases machinability
Manganese	Renders sulfur innocuous; increases hardenability, strength, hardness, abrasion resistance; increases rate of carbon penetration in carburizing
Molybdenum	Increases hardenability, hardness and strength at room and elevated temperatures, resistance to shock and corrosion; enhances creep strength; counteracts tendency toward temper brittleness
Nickel	Increases toughness, shock resistance (especially at subzero temperatures); strengthens as rolled and annealed steels; renders high chromium steels austenitic; improves resistance to heat and corrosion
Nitrogen	Increases strength and hardness; reduces ferritic grain size; as nitride, hardens surface; promotes austenite formation
Phosphorus	Increases strength, hardness, machinability, atmospheric corrosion resistance, wear resistance and electrical resistivity
Selenium	Increases machinability
Silicon	Deoxidizes; increases strength and oxidation resistance; decreases core (watt) loss in magnetizing silicon steel electrical sheets with alternating current
Sulfur	Increases machinability
Tantalum	Like columbium and titanium, stabilizes carbon to inhibit intergranular corrosion in high chromium and chromium-nickel stainless and heat resisting steels
Titanium	Deoxidizes; scavenges; has greatest known tendency to form carbide; see tantalum
Tungsten	Hardens and strengthens at room and high temperatures; increases hardenability; forms hard, abrasion resistant particles in tool steels
Vanadium	Increases strength, ductility, resiliency and endurance limit; promotes fine grain; forms carbide, nitride and oxide; dissolves in ferrite; when dissolved, increases hardenability; improves strength and hardness at elevated temperatures; prevents age hardening in low carbon rimmed steel
Zirconium	Deoxidizes; scavenges; combines with oxygen, sulfur, nitrogen; formation of zirconium nitride reduces age hardening in deep drawing steels; addition of over 0.10% Zr usually results in fine grain

Hardenability

Alloy steels are used for many products primarily because they are hardenable throughout their cross section in larger sizes than is possible with carbon steels. A few words[19] about this important characteristic of alloy steels follow.

Carbon steels are not through-hardening in heat treatment except in small sizes; consequently, they are not used for large sections where it is essential that properties be approximately the same throughout the full cross section.

Surface hardness attainable after quenching is largely a function of carbon content of the steel, while the depth of hardness depends on the carbon content, total content of alloying elements and grain size. It is necessary to add only sufficient quantity of the proper alloying element to make any steel through-hardening, taking into consideration the quenching media. It is unwise to over-alloy, because the excess alloying elements add little to the properties and may promote susceptibility to quenching cracks.

One measure of optimum as-quenched properties of alloy steel is the amount of martensite, such as 90%, in the quenched steel. Martensite is the hardest of the decomposition products of austenite. Grades such as 8630 are relatively lean in alloying elements, yet quench out in water at the center of small sections up to about 1 in. in dia; medium hardening grades, such as 4140, quench out in oil to about 1½ in.; and deep hardening grades, such as 4340, harden in oil throughout up to about 4 in.

In selecting an alloy steel for its hardenability characteristics, consideration should be given to the H-steels as they are produced to meet hardenability band limits. They are identified by the suffix letter "H" which is added to the conventional grade number. To afford steel producers the latitude necessary in manufacturing operations to meet a standard of hardenability limits, the chemical composition limits of those steels were modified somewhat from the ranges or limits applicable to the same grades when specified by chemical composition only. These modifications permit adjustments in manufacturing ranges of chemical composition to allow for individual plant melting characteristics which might otherwise influence the level and widths of the bands. The modifications are not large enough to influence the general characteristics of the original compositions under consideration.[20]

In addition to hardenability, other factors must be considered when such service conditions as low temperature impact, heavy

TABLE 10—CHARACTERISTICS AND USES OF ALLOY STEELS[28]

Identification	Distinguishing Characteristics	Typical Uses
Medium Manganese (Mn 1.75%)	Strength and workability	Machinery: logging, road and agricultural
Straight Chromium (Cr 0.95%)	Strength and workability	Springs, shear blades, wood cutting tools
3½% Nickel (C 0.30, Ni 3.5%)	Toughness	Rock drill and air hammer parts, crankshafts
Carbon-Vanadium (C 0.50, V 0.18%)	Resists impact	Locomotive parts
Carbon-Molybdenum (C 0.20, Mo 0.68%)	Resists heat	Boiler shells, high pressure steam equipment
High Silicon (Si 4.0%)	Electrical efficiency	Transformers, motors, generators
Silicon-Manganese (Si 2.00, Mn 0.75%)	Springiness	Automobile and railroad car springs
Chromium-Nickel (Cr 0.60, Ni 1.25%)	Surface readily hardened	Automobile ring gears, pinions, piston pins, transmissions
Chromium-Vanadium (Cr 0.95, V 0.18%)	Strength and hardness	Automobile gears, propeller shafts, connecting rods
Chromium-Molybdenum (Cr 0.95, Mo 0.20%)	Resists fatigue, impact, heat	Aircraft forgings and fuselages
Nickel-Molybdenum (Ni 1.75, Mo 0.35%)	Resists fatigue	Railroad roller bearings, automobile transmission gears
Manganese-Molybdenum (Mn 1.30, Mo 0.30%)	Resists impact and fatigue	Dredge buckets, rock crushers, turbine parts
Nickel-Chromium-Molybdenum (Ni 1.75, Cr 0.65, Mo. 0.35%)	Resists twisting	Diesel engine crankshafts

shock, creep resistance and resistance to temper brittleness are of major importance.

Through-hardening is considered undesirable for some applications: shallow-hardening is necessary in many shock applications because a softer core is essential to avoid excessive breakage.

Some of the atmospheric temperature applications of alloy steels shown in Table 10 are readily recognizable. Alloy steels have important uses also at elevated and subzero temperatures. One such elevated temperature use is described below.

Strength at subzero and elevated temperatures

The choice of steel for an unfired pressure vessel requires mainly temperature, pressure and corrosion considerations. ASTM A 300-52T Steel Plates for Pressure Vessels for Service at Low Temperatures and the 1951 API-ASME Code for Unfired Pressure Vessels indicate a low temperature limit of −50 F for carbon steel. The highest temperature at which the code gives maximum allowable stress values for any carbon steel plates is 1000 F, provided the pressure is not too high for the design. As the metal temperature rises to 1000 F, the increased thickness of carbon steel, required by rapidly decreasing allowable working stresses, emphasizes economics in the choice of a steel. Also, at temperatures above 850 F the possibility of carbon steel graphitizing, with loss of strength and ductility, is also a factor in the selection.

A carbon-molybdenum steel (0.5% Mo) was the choice for a reaction chamber of 8 ft inside dia and 56 ft long. For allowable working stresses at 950 F, under 350 psi, the needed thickness for the carbon-molybdenum steel was 1-13/16 in.; an appreciably thicker section would have been required with carbon steel. Estimated weights and costs of carbon steel and the alloy steel were:[21]

Steel	Weight	Cost
Carbon	173,000 lb	$45,000
0.5% Mo	115,000 lb	$35,000

High strength low alloy steels

High strength low alloy steel is a family name for about 15 steels of different chemical compositions which were developed to provide higher mechanical property values and greater corrosion resistance than are obtainable from conventional structural carbon steels containing copper.

These steels are used when savings in weight result from their higher tensile strength (generally 70,000 psi min), higher yield strength (generally 50,000 psi min) and atmospheric corrosion resistance. They are also selected when better durability is obtained from these and other characteristics such as abrasion resistance, resistance to battering, denting and piercing, strength in shear (about 52,000 psi), endurance limit, notch toughness, strength at low and moderately high temperature (at 1200 F, for example, about 21,000 psi ten str, 12,000 psi yld point and 60% elongation in 2 in.) and paint adherence. For thicknesses ½ in. and under the elongation in 2 in. is about 22% at room temperature. The steels can be magnet handled.

They are fabricated by welding, shearing, gas cutting, punching, drawing and riveting, and are intended for use without quenching and tempering treatment by the fabricator. In the fabrication of certain complex structures, stress relieving or intermediate annealing might be necessary. In welded structures, preheating or postheating generally is not required.

Uses include agricultural equipment, air conditioning equipment, containers, mining equipment, railway hopper cars, slag cars, snow cruisers, tanks, trailers, truck bodies (delivery, dump and tank) and related structural applications.

The steels are available as hot rolled bars and bar size sections, structural sections, plates, hot rolled and cold rolled sheets, hot rolled and cold rolled strip, Yoder mill sections and a nailable floor section.

Various combinations of alloying elements are employed by

different producers to obtain the foregoing properties. The total content of alloying elements, including manganese, is 2 to 3% for most of the steels. In some cases the chemical composition of a successful high strength low alloy steel developed from the nature of the raw material sources of an individual plant or company.

Carbon is maintained generally at a level to insure freedom from excessive hardening after welding and to retain ductility. Manganese is employed mainly as a strengthening element. Copper is generally used to enhance resistance to atmospheric corrosion and as a strengthening element. Sometimes phosphorus is similarly used. Chromium, molybdenum, nickel, silicon, titanium, vanadium and zirconium, as may be selected by individual producers, contribute to strength, toughness, corrosion resistance and some other properties.

Stainless and Heat Resisting Steels

Corrosion resistance, strength, ductility, heat resistance and magnetic properties, together with fabricating properties, comprise the main reasons for choosing these steels. Sometimes the choice involves some compromise when two or more properties are needed. For example, when corrosion resistance and machinabilitly are both required the choice of free machining steel containing significant amounts of sulfur or selenium may result in less corrosion resistance than the comparable type without those elements. Also, additional choices may follow: sulfur treated steel for deep or heavy cuts and selenium treated for shallow or light cuts.

The steels are designated by "type" numbers, as shown in Table 11, rather than by "grade" numbers, because for several types modification of the type composition permits further development of needed product performance properties or aids in manufacturing the product. Modified compositions are generally used in manufacturing stainless and heat resisting tubular products, for example.

The property of corrosion resistance leads to dependent or related properties such as smoothness, finish, appearance, ease of cleaning, ease of sterilizing, relative freedom from staining the steel container or contaminating the contained product and corrosion resistance of welds and adjoining metal. Similarly, heat resistance may be associated with oxidation, abrasion, erosion, corrosion, strength and ductility, as well as galling and seizing. When a type is selected primarily because it is nonmagnetic, the purchaser should ascertain whether fabrication, such as cold working, is likely to make the steel slightly magnetic. And, of course, fabrication properties should be reviewed for every type or modification under consideration.

Despite widespread use, the bulk of the stainless and heat resisting steels are scarcely a generation old. Consequently, for some applications, the choice of a steel follows extensive study of comparative data on fabrication and performance, and even pilot or experimental fabrication and service testing. This is especially true in anticipating the behavior of the steels under corrosive conditions. The limitations of laboratory corrosion data in predicting service performance are well recognized. There are also limitations in predicting performance on the basis of service data, because "similar" corrosive environments may significantly differ due to "slight" variations in temperature, concentration, ionization, continuity of exposure, continuity of stress and presence or absence of impurities.

When in doubt about the appropriate steel for a particular corrosive environment, those who choose steel should consult the producers. Similarly, the producers should be consulted about fabrication. Considerable information on behavior of the steels in various corrosive environments and methods of fabricating the steels are available. Three typical publications are listed in references 24, 25 and 26. Fabricators and users of stainless steel should remember that the rusting of carbon steel wool embedded in the steel's surface "stains" stainless steel.

The steels in Table 11 comprise four groups: chromium-nickel (austenitic), such as the 300 series of type numbers; chromium hardenable (martensitic), such as 403, 410, 414, 416, 416 Se, 420, 431, 440A, 440B and 440C, chromium nonhardenable (ferritic), such as 405, 430, 430F, 430FSe and 446; and 4-6% chromium hardenable (martensitic), such as 501 and 502.[33]

Chromium-nickel (austenitic) steels

The chromium content of this group varies from 16 to 26%, nickel from 6 to 22% and carbon from 0.03 max to 0.25% max. These steels generally provide more corrosion resistance than those of the remaining groups. They can be fabricated by conventional methods, including deep drawing and welding, and are hardenable by cold working, not by heat treatment. Cold working transforms the austenite (metastable at room temperature) to a low carbon martensite.[8] The steels have an austenitic structure and are nonmagnetic in the annealed condition. Except for 310 and 314, they are slightly magnetic after cold working.

Other elements are present in significant amounts in some types: selenium and sulfur to improve machinability; silicon to increase oxidation resistance; molybdenum to enhance creep strength and corrosion resistance; columbium, tantalum and titanium to inhibit intergranular corrosion.

By controlling the chromium-nickel ration and degree of cold reduction, steel of high tensile strength is produced which is especially suitable for lightweight welded structures.[24]

The chromium-nickel steels have good oxidation resistance and high rupture and creep strength values. The relatively high coefficient of expansion of these steels should be considered in designing

Quality and Commodity Designations

"Quality," like "peace" and "love," is a wonderful word! Only as it is qualified does the word acquire meaning, such as "drawing quality" or "bearing quality" when related to the fabrication or performance of an identified steel product. As applied to steel, quality relates to the fabrication and performance of a product to a broader extent than is indicated by chemical composition, mechanical, or other properties. Sometimes quality infers product characteristics which are determined only by product use and are not readily measurable before use.

Quality is used to identify steel by quality factors such as steelmaking process, test results, fabricating properties, performance properties or combinations of them.

Steelmaking Process

Associating quality with steelmaking process, without reference to other quality factors, can lead to uneconomical decisions in choosing a steel. On the need for qualifying quality, Parker[4] states: "One frequently hears it said without qualification that bessemer steel is of a poor quality. That is not so. It can fairly be said that bessemer steel is a poor quality from which to make an aircraft engine crankshaft; but bessemer steel is the proper quality from which to make an aircraft engine sparkplug body.

"The steel which can be successfully used in making the crankshaft cost much more than the sparkplug steel, but its properties are such that it could not be fabricated and machined with the rapidity necessary to turn out a low-priced product like a sparkplug. Used in the proper place bessemer steel is the best quality which can be bought.

"Electric furnace steel is frequently named as being the finest quality steel—and it undoubtedly is, in an abstract sense. But if we were to use electric furnace steel for screen-door hinges on our front porches it would be a 'poor' quality steel because it would cost far too much and would not do any better job than a hinge made of bessemer or open hearth steel. It is not possible to evaluate the quality of steel simply by referring to the process by which it was made.

"In order properly to evaluate steel quality one must study end use and fabrication methods as well as such other factors as the method by which the steel is manufactured, the nature and quantities of alloying elements present, the deoxidation practice, ingot practice, rolling practice and test methods used to evaluate the physical condition and mechanical properties of the steel."

Test Results

Quality is used in many ways to identify steel by test results. "Structural quality" is used for carbon steel structural sections ordered to specifications containing mechanical property requirements, such as ASTM A 7 Steel for Bridges and Buildings. Structural quality sections are used in bridges, buildings, locomotives, railroad cars and other mobile equipment.[15] Structural quality also is one of the qualities to which carbon steel plates are produced for similar uses.

Test results are related to quality in other designations, such as "bearing quality" hot rolled alloy steel for the manufacture of ball and roller bearings. Steel of that quality is usually furnished in AISI-SAE alloy carburizing grades, their high carbon chromium series, or to ASTM A 295 Carbon-Chromium Ball- and Roller-Bearing Steels or its equivalent.[16] Test results include decarburization limits, inclusion ratings and hardness maxima. In addition, ASTM A 295 stated: "The manufacturer shall be held responsible for the quality of the materials furnished and shall make the necessary tests to insure this quality."

Product Fabrication

Quality in terms of fabricating properties is expressed in "cold rolled drawing quality" carbon steel sheets. Steel of that quality is used for making identified parts that are too difficult for the drawing properties of any other carbon steel sheet quality, within the breakage allowances as negotiated between the purchaser and producer.[17] This quality and some others usually are not specified to chemical composition because composition is only one of many important factors affecting drawing properties. Each steel producer, with his available raw materials and manufacturing equipment, balances those factors to obtain steel with drawing properties suitable for the identified product.

Product Performance

"Electric arc welding quality" carbon steel wire for electrodes is essentially a performance quality. The specification requirements for chemical ranges and limits usually are negotiated. Manufacturing wire of this quality involves closely controlled chemical composition, selection of heats, selection of the most uniform portions of ingots from selected heats, selection and preparation of billets and testing of rods and wire.[18]

Commodity Descriptions

Performance properties are included also in some "commodity" descriptions of steel products, such as that of "valve spring wire." This quality of wire is used primarily for springs subjected to dynamic stress repetitions with maximum life expectancy.[18] Part of that commodity description follows. "The surface of this wire is characterized by its freedom from any areas of free ferrite or of detrimental reduction of carbon content as well as from seams, scratches, die marks, pits, etc., or any other defects that would act as stress raisers, thereby impairing the fatigue value of the spring."

Steel Availability and Delivery

In choosing a steel, two occasionally overlooked aspects of quality are wide availability of source of steel and speed of delivery. Not every steel producer makes every quality. The additional controls in manufacturing, additional inspection and testing and holding of steel pending completion of inspection and testing can retard delivery.

high temperature equipment. Their rate of thermal conductivity is somewhat lower than that of carbon steel; however, this has not been a deterrent factor in process equipment.[24]

Corrosion resistance, ease of cleaning and excellent fabricating characteristics enable the steels to be used extensively in chemical, dairy and food processing industries. Their strength and oxidation resistance are useful in oil refining and power production.[24]

The designation "18:8" has been given to some of these steels to identify approximately the ratio of chromium to nickel. A typical "18:8" is Type 302. Although this type is readily welded, the heat of welding may cause carbides to precipitate in the weld and adjoining metal if sufficiently rapid cooling is not attained. The welded and adjoining zones are susceptible to intergranular corrosion because the precipitation of chromium rich carbides depletes chromium at the grain boundaries. This condition can be corrected by annealing the welded part above 1900 F to redissolve the carbides, followed by rapid cooling to retain them in solution.[8] If that treatment is not feasible, 321, 347 or 304L can be used. In Type 321 titanium combines with the carbon to form a stable carbide, thus permitting the retention of dissolved chromium. Similarly, in Type 347 columbium and tantalum combine with carbon. No stabilizing element is required in Type 304L because the carbon is held to a maximum of 0.03%. The effect of carbide precipitation, due to welding, on corrosion resistance has been overemphasized for some uses: household cooking, low temperature food handling and dairy products processing, for example, are not significantly affected by that precipitation. However, service at elevated temperature within the carbide precipitation range must be considered in choosing a steel.

Chromium hardenable (martensitic) steels

In this group the chromium varies from 11.50 to 18.00%, nickel is intentionally present only in Types 414 and 431 (each 1.25 to 2.50%) and carbon ranges from 0.15 max to 1.20% max. The

TABLE 11—USES OF STAINLESS AND HEAT RESISTING STEELS [8, 24, 30, 31, 32, 33]

Type No.	% of Chief Elements and Uses
	CHROMIUM-NICKEL (AUSTENITIC)
302	C 0.15 max, Cr 17.00–19.00, Ni 8.00–10.00 Architectural exteriors; baking, beverage, brewing, dairy, food processing and packing, food serving and handling, oil refining, pharmaceutical, refrigeration, and sporting equipment; kitchen utensils and equipment; bottling and packaging machinery; jewelry
302B	C 0.15 max, Cr 17.00–19.00, Ni 8.00–10.00, Si 2.00–3.00 Annealing covers, burner sections, furnace parts
303	C 0.15 max, Cr 17.00–19.00, Ni 8.00–10.00, P 0.20 max, S 0.15 min Bolts, bushings, fastenings, nuts, shafts; applications requiring a minimum of seizing or galling
304	C 0.08 max, Cr 18.00–20.00, Ni 8.00–12.00 Beer barrels, cooling coils, evaporators, flue liners, shipping drums, still tubes
305	C 0.12 max, Cr 17.00–19.00, Ni 10.00–13.00 Coffee urn tops, reflectors, utensils; spinning, drawing and cold heading applications
308	C 0.08 max, Cr 19.00–21.00, Ni 10.00–12.00 High temperature plant equipment, industrial furnaces, welding rods
309	C 0.20 max, Cr 22.00–24.00, Ni 12.00–15.00 Annealing boxes, baffle plates, dryers, furnace arch supports, oil burner parts, recuperators, rolls for roller hearth furnaces, dye house and paper mill equipment
310	C 0.25 max, Cr 24.00–26.00, Ni 19.00–22.00, Si 1.50 max Air heaters, carburizing boxes, gas turbine parts, heat exchangers, skid rails, soot blower tubing, nozzle diaphragm assemblies for turbojet engines
316	C 0.08 max, Cr 16.00–18.00, Ni 10.00–14.00, Mo 2.00–3.00 Chemical, corn products refining, pharmaceutical, photographic and textile finishing equipment; piping, valves and fittings of paper mill digestors; meat curing tanks; brine tanks
317	C 0.08 max, Cr 18.00–20.00, Ni 11.00–15.00, Mo 3.00–4.00 Dyeing, pharmaceutical and ink manufacturing equipment
321	C 0.08 max, Cr 17.00–19.00, Ni 9.00–12.00, Ti 5 times C min Aircraft collector rings and exhaust manifolds, jet engine parts, welded equipment
347	C 0.08 max, Cr 17.00–19.00, Ni 9.00–13.00, Cb-Ta 10 times C min Welded storage tanks for organic chemicals; all welded railroad tank cars for chemicals; heat resistors; jet engine parts; heavy wall welded equipment
	CHROMIUM HARDENABLE (MARTENSITIC)
403	C 0.15 max, Cr 11.50–13.00 Steam turbine blading, buckets and valves; stressed parts in gas turbines
410	C 0.15 max, Cr 11.50–13.50 Fishing tackle, hardware, keys, lamp brackets; liners for reaction chambers; micrometer parts; paper mill beater bars; scissors; water well shutter screens; oil field valves; petroleum fractionating towers, supports, caps, trays, vapor risers
414	C 0.15 max, Cr 11.50–13.50, Ni 1.25–2.50 Beater bars, gage parts, scissors, shafts, spindles, valve seats
416	C 0.15 max, Cr 12.00–14.00, S 0.15 min Machined outboard motor parts, pump and valve parts
420	C over 0.15, Cr 12.00–14.00 Knife blades, dental and surgical instruments, springs, valve seats, vegetable choppers
431	C 0.20 max, Cr 15.00–17.00, Ni 1.25–2.50 Stressed aircraft members needing high yield strength and shock resistance
440A	C 0.60–0.75, Cr 16.00–18.00, Mo 0.75 max Surgical instruments, valves
440B	C 0.75–0.95, Cr 16.00–18.00, Mo 0.75 max Valves, bearings
440C	C 0.95–1.20, Cr 16.00–18.00, Mo 0.75 max Bearings, races, valves, valve seats
	CHROMIUM NONHARDENABLE (FERRITIC)
405	C 0.08 max, Cr 11.50–14.50, Al 0.10–0.30 Welded assemblies operating at temperatures below 1200 F that cannot be annealed after welding; heat exchanger tubes; linings for vessels for petroleum refining
430	C 0.12 max, Cr 14.00–18.00 Automobile trim, builders hardware, fasteners, interior architectural trim, nitrogen fixation equipment, scientific apparatus; rubber plant and tobacco machinery; recuperators, pyrometer protection tubes, bubble caps; trim on cabinets, electric mixers, toasters
430F	C 0.12 max, Cr 14.00–18.00, S 0.15 min Screws, nuts, bolts, fittings
446	C 0.20 max, Cr 23.00–27.00, N 0.25 max Metal to glass seals; annealing boxes; baffle plates; burner nozzles; glass molds; stack dampers; stirring rods; X-ray tube bases and lead-in wires; dehydrogenation equipment

contents of carbon and chromium, and nickel when present, are proportioned to permit hardening by heat treatment The steels are magnetic in all conditions. Generally these steels are not as corrosion resistant as those of the austenitic and ferritic groups and are used in mildly corrosive environments.[24]

The hot working or forging characteristics of the chromium hardenable steels are satisfactory; they have fair cold forming characteristics. They weld readily but require annealing or tempering after welding.[24] They are air hardening and should be slowly cooled, or annealed after forging, to prevent cracking.

Chromium hardenable steels are suitable for uses requiring high strength, hardness and resistance to abrasion or either wet or dry erosion, as in steam and gas turbine parts, bearings and cutlery.

Chromium nonhardenable (ferritic) steels

The chromium to carbon ratio of these steels does not permit hardening by heat treatment. Their hardness can be increased by cold working. Chromium varies from 11.5 to 27% and carbon from 0.08 max to 0.20% max. The steels are magnetic in all conditions.

Chromium nonhardenable steels have good resistance to oxidation and corrosion. With fair ductility, they can be formed, bent, spun, lightly drawn and buffed to a high finish resembling chromium plate in color. They have low tensile and creep strength values at high temperature.[24].

Typical uses for these steels are automotive trim, high temperature service requiring resistance to scaling, some applications involving nitric acid and others for which their low coefficient of expansion is suitable.[24]

4-6% chromium hardenable (martensitic) steels

These are not "stainless" if 11.5% is considered to be the minimum chromium content for "stainlessness."[24] However, these steels have corrosion resistance characteristics and have become established in the family of stainless and heat resisting steels. The two types, 501 and 502, are magnetic in all conditions and are alike in chemical composition except for carbon content: over 0.10% for 501 and 0.10% max for 502.

The steels are used where carbon steels do not suffice and the properties of steels containing 11.5% or over chromium are not required. Significant uses of the types or type modifications include tubes and tubular products for oil refining, blowing equipment such as wind boxes carrying high temperature gases, and recuperators.

Some uses of some type numbers are given in Table 11.

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MATERIALS ENGINEERING
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MATERIALS DATA SHEET

Cellulose Acetate Molding Materials

Cellulose acetate molding compositions are made from cellulose acetate, plasticizers, pigments and dyes. They are thermoplastic materials and their chief characteristics are toughness, high impact strength and ease of fabrication. Most commonly used are:–

Type I–Medium. These materials are recommended for general use because of good fabricating qualities and finished properties which are adequate for general use.

Type II–Hard. These materials have better than average heat resistance for any given flow.

Type III–Soft. These materials have better than average toughness for any given flow.

Type	ASTM Test Conditions	Type I–Medium				
		MH-1	MH-2	MH-3	MS-1	MS-2
PHYSICAL PROPERTIES						
Specific Gravity	D792	1.28–1.34	1.27–1.32	1.27–1.34	1.28–1.34	1.27–1.31
Thermal Cond, Btu/hr/sq ft/ft/°F	C177	0.10–0.19	0.10–0.19	0.10–0.19	0.10–0.19	0.10–0.19
Coef of Exp per °F	D696	$4.4–9.0 \times 10^{-5}$	$4.4–9.0 \times 10^{-5}$	$4.4–9.0 \times 10^{-5}$	$4.4–9.0 \times 10^{-5}$	$4.4–9.0 \times 10^{-5}$
Spec Ht, Btu/lb/°F	—	0.3–0.42	0.3–0.42	0.3–0.42	0.3–0.42	0.3–0.42
Refractive index	D542	1.46–1.50	1.46–1.50	1.46–1.50	1.46–1.50	1.46–1.50
Transmittance (Luminous) %	D791	80–90	80–90	80–90	80–90	80–90
Haze %	D672	4–10	4–10	4–10	3–8	3–8
Water Absorption, 24 hr %	D570	2.2–5.5	2.4–4.4	2.2–2.7	2.2–5.7	2.5–5.0
Flammability in./min (over 0.050 in.)	D635	0.5–2.0	0.5–2.0	0.5–2.0	0.5–2.0	0.5–2.0
MECHANICAL PROPERTIES						
Tensile Str, psi	D638	3800–6500	3800–5900	3800–5700	3000–5800	2700–5100
Elong %	D638	21–44	18–44	29–42	27–46	25–47
Hardness, Rockwell	D785	R84–115	R84–112	R85–114	R72–109	R70–102
Impact Str, Izod Notched (ft-lb per in. of notch)	D236	1.1–3.4	1.7–3.6	1.2–3.0	1.4–3.8	2.4–4.0
Mod Elasticity in Flexture, psi	—	$1.6–3.5 \times 10^5$	$1.4–2.2 \times 10^5$	$1.6–2.2 \times 10^5$	$1.3–3.1 \times 10^5$	$1.1–1.7 \times 10^5$
Compressive Str, psi (at fracture)	D695	16,000–25,000	16,000–18,000	16,000–23,000	14,500–23,000	14,500–23.000
ELECTRICAL PROPERTIES						
Elect Res, ohm-cm	D257	10^{10}–10^{13}	10^{10}–10^{13}	10^{10}–10^{13}	10^{10}–10^{13}	10^{10}–10^{13}
Dielectric Str (Short Time) volts/mil	D149	250–365	350–365	250–365	250–365	250–365
Dielectric Constant:						
60 cycles	D150	3.5–7.5	3.5–7.5	3.5–7.5	3.5–7.5	3.5–7.5
1,000,000 cycles	D150	3.2–7.0	3.2–7.0	3.2–7.0	3.2–7.0	3.2–7.0
Loss Factor						
60 cycles	D150	0.03–0.38	0.03–0.38	0.03–0.38	0.03–0.38	0.03–0.38
1,000,000 cycles	D150	0.03–0.33	0.03–0.33	0.03–0.33	0.03–0.33	0.03–0.33
FABRICATING PROPERTIES						
Injection Molding Pressure, psi	—	8000–32,000	8000–32,000	8000–32,000	8000–32,000	8000–32.000
Injection Molding Temp, F	—	370–440	370–440	370–440	355–420	355–420
Compression Ratio (Bulk Factor)	—	2.0–2.6	2.0–2.6	2.0–2.6	2.0–2.6	2.0–2.6
Compression Molding Pressure, psi	—	500–5000	500–5000	500–5000	500–5000	500–5000
Compression Molding Temp, F	—	300–350	300–350	300–350	280–330	280–330
Extruding Temp, F	—	370–400	370–400	370–400	355–385	355–385
MAXIMUM RECOMMENDED SERVICE TEMP, F	—	As these are thermoplastic materials, they gradually become softer as the temperature rises. The maximum service temperature will depend on such factors as formula, design of part, humidity, service conditions, etc.				
CORROSION RESISTANCE	—	Unattacked by water, salt water solutions, white gasoline, oleic acid, 5% acetic acid; dilute sulfuric acid; decomposed by 30% sulfuric, 10% nitric, 10% hydrochloric acids, sodium hydroxide, 10% ammonium hydroxide; dissolved by acetone and ethyl acetate				
USES	—	Automotive and radio knobs, tool handles, business machine keys; electrical items such as fluorescent lamp supports, coil spools and contact bases; toys and novelties; sun glass goggles and frames, spectacle frames; buttons and tags				

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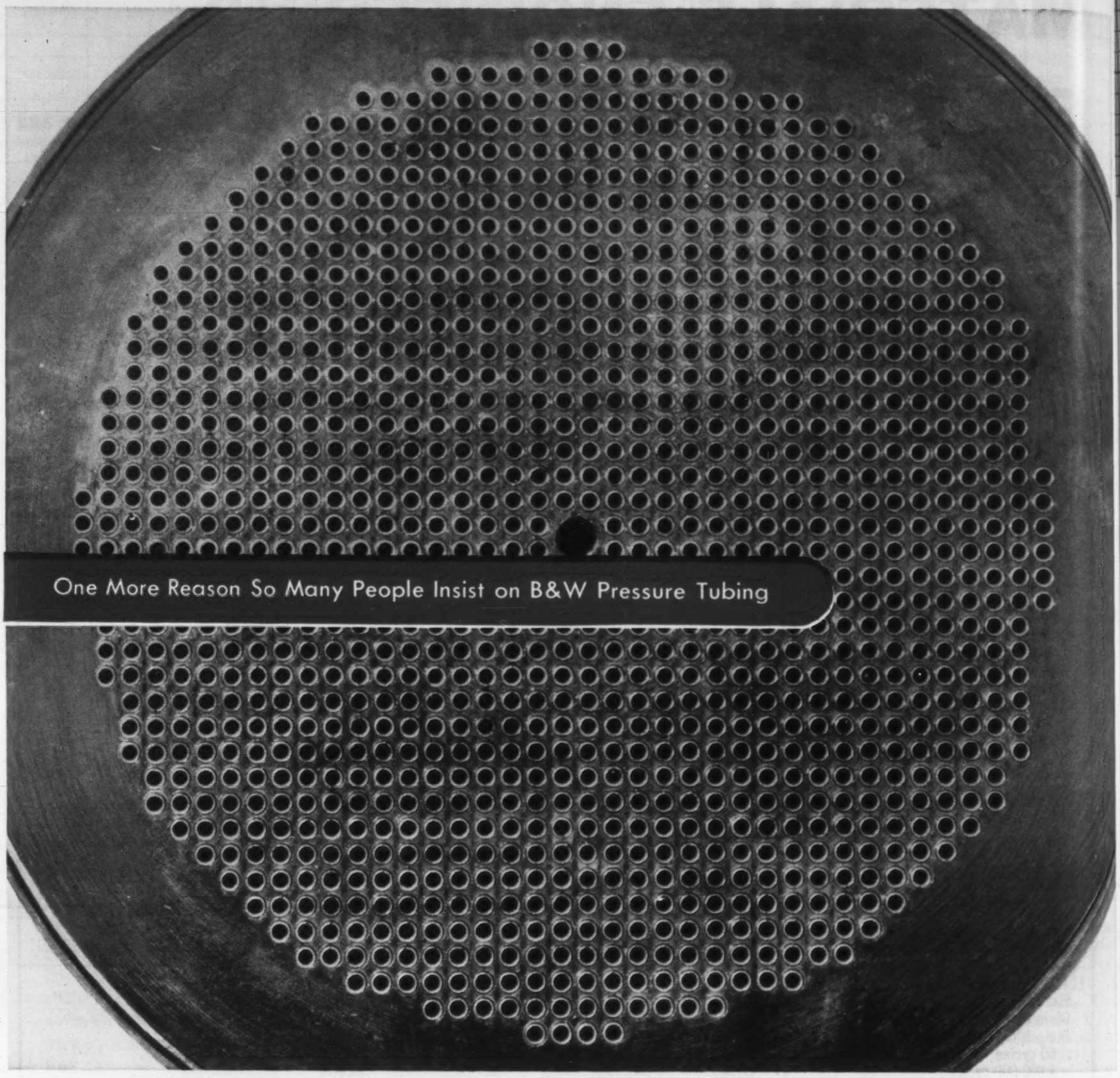
(Continued on page 131)



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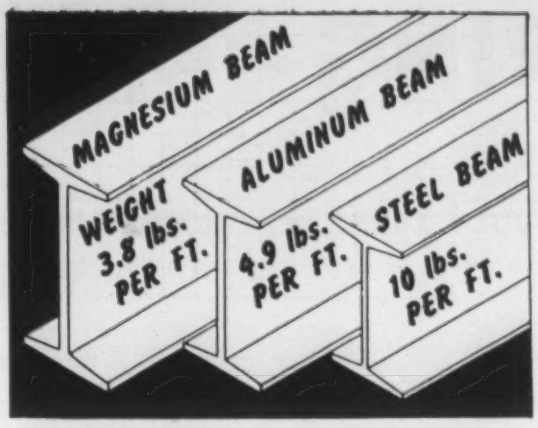
Cellulose Acetate Molding Materials—continued

Type	ASTM Test Conditions	Type II—Hard			
		H6-1	H4—1	H4-2	H2-1
PHYSICAL PROPERTIES					
Specific Gravity	D792	1.29–1.34	1.28–1.34	1.28–1.33	1.28–1.34
Thermal Cond, Btu/hr/sq ft/ft/°F.	C177	0.10–0.19	0.10–0.19	0.10–0.19	0.10–0.19
Coef of Exp per °F	D696	$4.4–9.0 \times 10^{-5}$	$4.4–9.0 \times 10^{-5}$	$4.4–9.0 \times 10^{-5}$	$4.4–9.0 \times 10^{-5}$
Spec Ht, Btu/lb/°F	—	0.3–0.42	0.3–0.42	0.3–0.42	0.3–0.42
Refractive Index	D542	1.46–1.50	1.46–1.50	1.46–1.50	1.46–1.50
Transmittance (Luminous)	D791	75–90	75–90	75–90	80–90
Haze %	D672	4–15	4–15	4–15	4–10
Water Absorption, 24 hr %	D570	2.0–3.5	1.9–3.6	2.2–2.7	2.2–5.3
Flammability in./min (over 0.050 in.)	D635	0.5–2.0	0.5–2.0	0.5–2.0	0.5–2.0
MECHANICAL PROPERTIES					
Tensile Str, psi	D638	6000–8500	5600–7500	5400–7600	4600–6600
Elong, %	D638	6–31	12–35	16–35	17–38
Hardness, Rockwell	D785	R112–123	R106–121	R111–121	R101–119
Impact Str, Izod Notched (ft-lb per in. of notch)	D256	0.4–1.9	0.6–2.3	0.6–2.0	0.7–2.7
Mod Elasticity in Flexture, psi	—	$2.6–4.0 \times 10^5$	$2.4–3.4 \times 10^5$	$2.3–3.3 \times 10^5$	$1.9–3.3 \times 10^5$
Compressive Str, psi (at fracture)	D695	25,000–36,000	22,000–33,000	28,000–33,000	19,000–25,000
ELECTRICAL PROPERTIES					
Elect Res, ohm-cm	D257	$10^{10}–10^{13}$	$10^{10}–10^{13}$	$10^{10}–10^{13}$	$10^{10}–10^{13}$
Dielectric Str (Short Time) volts/mil	D149	250–365	250–365	250–365	250–365
Dielectric Constant:					
60 cycles	D150	3.5–7.5	3.5–7.5	3.5–7.5	3.5–7.5
1,000,000 cycles	D150	3.2–7.0	3.2–7.0	3.2–7.0	3.2–7.0
Loss Factor					
60 cycles	D150	0.03–0.38	0.03–0.38	0.03–0.38	0.03–0.38
1,000,000 cycles	D150	0.03–0.33	0.03–0.33	0.03–0.33	0.03–0.33
FABRICATING PROPERTIES					
Injection Molding Pressure, psi	—	8000–32,000	8000–32,000	8000–32,000	8000–32,000
Injection Molding, Temp, F	—	420–490	410–480	410–480	390–460
Compression Ratio (Bulk Factor)	—	2.0–2.6	2.0–2.6	2.0–2.6	2.0–2.6
Compression Molding Pressure, psi	—	500–5000	500–5000	500–5000	500–5000
Compression Molding Temp, F	—	350–420	330–390	330–390	320–370
Extruding Temp, F	—	420–450	405–455	405–435	390–420
MAXIMUM RECOMMENDED SERVICE TEMP, F	—	As these are thermoplastic materials, they gradually become softer as the temperature rises. The maximum service temperature will depend on such factors as formula, design of part, humidity, service conditions, etc.			
CORROSION RESISTANCE	—	Unattacked by water, salt water solutions, white gasoline, oleic acid, 5% acetic acid; dilute sulfuric acid; decomposed by 30% sulfuric, 10% nitric, 10% hydrochloric acids, sodium hydroxide; 10% ammonium hydroxide; dissolved by acetone and ethyl acetate			
USES	—	Automotive and radio knobs, tool handles, business machine keys; electrical items such as fluorescent lamp supports, coil spools and contact bases; toys and novelties; sun glass goggles and frames, spectacle frames; buttons and tags			

Prepared with the assistance of the Manufacturing Chemists' Association, Inc.
Based on the Chemists' Association publication, "Technical Data on Plastics", 1952

(Note: Another "Materials Data Sheet" on cellulose acetate molding materials will be published in next month's issue.)



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Effect of Silicon in Submerged Arc Welds

Does high silicon content in submerged arc welds produce brittle welds? Results of a recent investigation provide the answer.

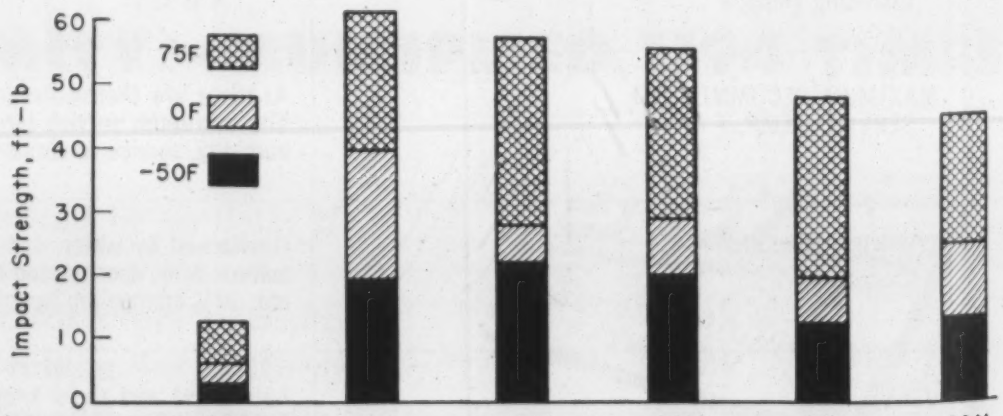
by W. Simon, *Materials Engineering Dept., Westinghouse Electric Corp.*

■ Multi-pass submerged arc welding has become common in recent years for the welding of thick mild steel plate. The process employs a consumable wire rod which is fed continuously and progressively into the area being welded. The weld metal deposited from the end of the rod is protected from heat loss and oxidation by submersion in a granular flux.

Experience has proved that cleaner welds with greater penetration can be accomplished more rapidly with fluxes that produce weld metal with a high silicon content. However, use of such fluxes has been inhibited by the belief that high silicon content produces a brittle weld. It was the purpose of a recent investigation to determine the origin of the large amounts of silicon in the weld metal and to study its effect.

Each manufacturer marketing fluxes for use in the submerged arc process offers a variety of flux compositions. Depending upon which flux is used, the silicon content of the weld metal can vary from 0.20 to 1.00% and the manganese content from 0.45 to 1.60%. The plate welded during the investigation was a low carbon steel with the following nominal composition: 0.10-0.25 carbon, 0.30-0.60 manganese, 0.04 max phosphorus and 0.20% max silicon.

The composition of the five fluxes studied was determined spectrographically to be mainly mineral compounds of aluminum, calcium, silicon, magnesium and manganese. These are in the form of oxides and complex silicates. Metallic silicon is also a constituent, in the form of ferrosilicon, in quantities varying with the type of flux. The function of the metallic silicon is that of a scavenging de-oxidizer which,



Flux Used	Steel Plate	90M	50M	80M	70M	20M
Silicon in Weld, %		0.26	0.27	0.39	0.63	0.80
Manganese in Weld, %		1.46	1.46	1.06	0.83	0.50
Ratio of Mn to Si		5.6	4.83	2.72	0.93	0.63

Impact strength (Charpy V-notch) of multi-pass submerged arc welds at three different temperatures.

after oxidation, becomes a slag constituent. When an excess of silicon prevails, the residual silicon is deposited in the weld metal; but when a balance exists, relatively little silicon is deposited. It appears that the quantity of manganese oxides present determines, indirectly, the amount of silicon within the weld metal.

The total content of silicon and manganese in the fluxes is listed in Table 1. These analyses do not indicate how much silicon can be transferred to the weld metal since the analysis lumps the total silicon content and permits no measure of the quantity of metallic silicon involved. Yet only metallic silicon is significant in this respect. The quantity of manganese involved is also significant since it is present as reducible oxides, which can oxidize metallic silicon into a slag which is removed from the weld. The accompanying curve shows that as the quantity of manganese in the weld metal increases, that of silicon decreases.

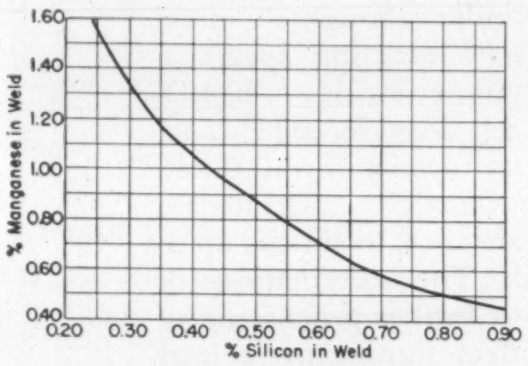
Effects of silicon on properties

When 1½-in. steel plates were welded by means of eight to ten pass welds and then cold rolled into 30-in. o.d. barrels, tests showed that welds made with all five fluxes were ductile enough to be severely deformed in cold bending without signs of cracking. (See Table 2.)

Two of the three most ductile welds contain relatively large amounts of silicon while the two welds with lowest ductility contain very little silicon. These results suggest that the proportion of silicon present, within the range considered, does not lower weld metal ductility. Further, ductility in each instance is high, exceeding the standard appreciably. (A weld metal is considered ductile when a free bend test results in elongation of 15% in 1 in.)

Longitudinal tensile testing data shows that tensile strength, yield strength and ductility for all specimens is equal to, or better than, that required for mild steel plate.

The welds, tested by Charpy V-notch specimens, gave a notch toughness far above that of the steel plate. The superiority of the



Per cent of silicon vs per cent of manganese at top of ten pass welds made with various fluxes.

TABLE 1 – TOTAL SILICON AND MANGANESE ANALYSES OF FLUXES

Flux No.	Total	
	Si (%)	Mn (%)
20 M	20.2	0.38
70 M	23.1	7.60
80 M	17.0	5.40
90 M	15.2	21.0
50 M	19.2	31.8

TABLE 2 – FREE BEND TEST WELD DUCTILITY AND ANALYSIS OF WELDS

Flux No. Used	% Elong in 1 in.	Si (%)	Mn (%)	Remarks
90 M	25	0.28	1.45	Failed at edge of weld
80 M	26	0.36	1.06	Failed in weld
20 M	36	0.76	0.49	Failed in weld
50 M	46	0.28	1.35	Failed at edge of weld
70 M	56	0.57	0.81	No failure

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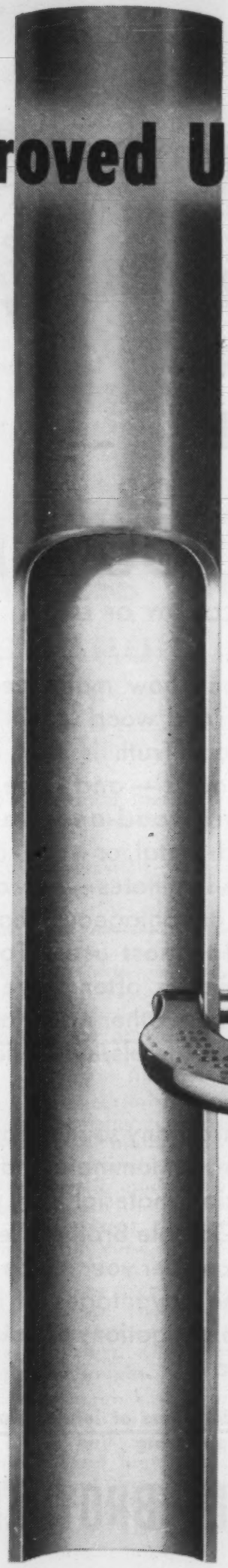

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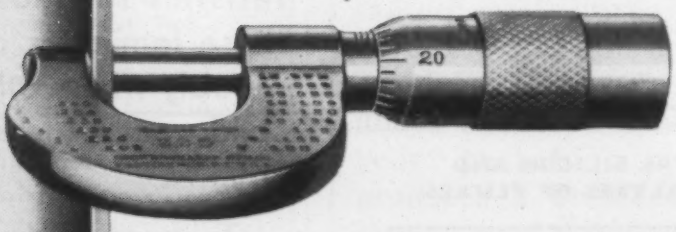

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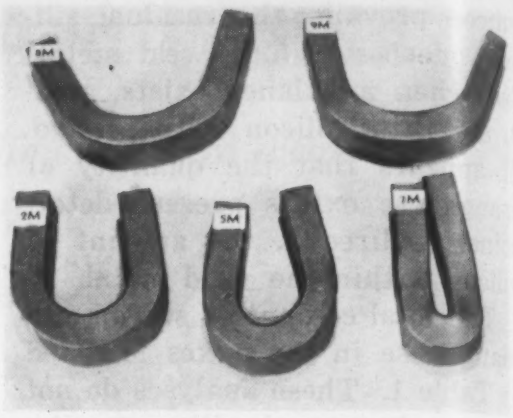
continued from p. 133



***Free bend test ductility** of submerged arc welded mild steel plates made using various fluxes.*

various welds under impact testing over the steel plate is clearly seen in the accompanying chart. A study of the chart shows that the high impact values are not governed by the amount of silicon in the weld metal, but are determined instead by the proportion of manganese to silicon. Thus, notch ductility is highest for weld metal resulting from No. 90 M flux, with that from 50 M, 80 M, 70 M and 20 M fluxes following in order.

On the basis of these impact tests, it appears that a lowering of weld metal impact values is solely due to relatively high silicon content and low manganese content. Hence, it is inaccurate to say that one weld is tougher than another merely because the first is low in silicon content. More accurately, toughness is dependent upon the proportion of the two elements.

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Correction

Case history 46 (p. 133) of the special article on "Improving Product Quality Through Better Materials" in the May, 1955 issue erroneously stated that the new material used for the delay line coil form was "nylon". It should have read "styrene copolymer".

New Materials, Parts and Finishes | and related equipment

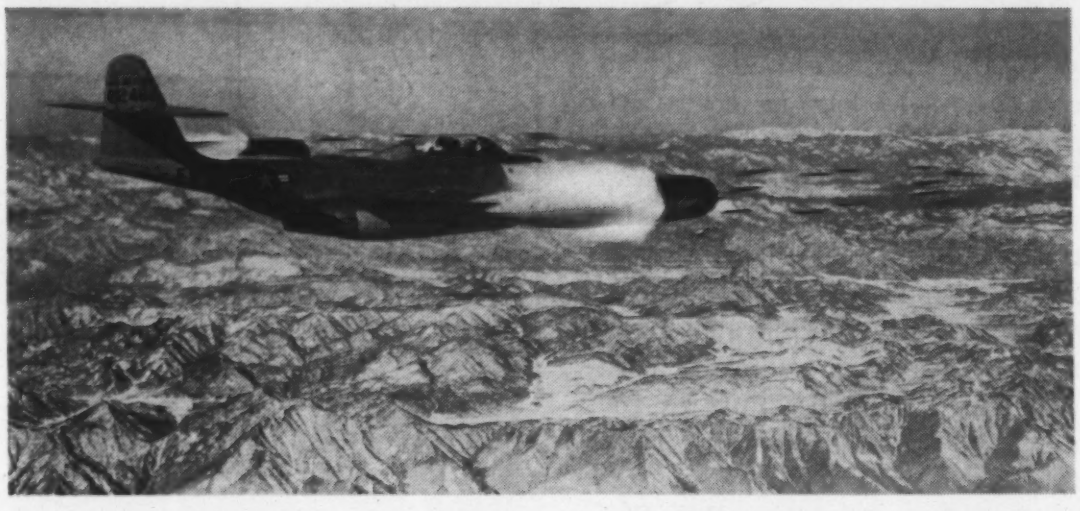
New Aluminum Alloy for High Temperature Service

A new aluminum alloy which is said to retain a tensile strength in the —T6 condition of 29,000 psi after 1000 hr at 500 F and 18,000 psi after 1000 hr at 600 F has been developed by *Aluminum Co. of America*, 763 Alcoa Bldg., Pittsburgh 19, Pa. Designated Alcoa alloy X2219, the alloy is available for evaluation in experimental quantities in rolled and extruded shapes and forgings.

X2219 is a member of the aluminum-copper group of aluminum alloys containing small additions of several other elements. In the solution heat-treated and aged condition it is said to have good mechanical properties, tensile and yield strength and resistance to creep at temperatures in the 500-600 F range. The accompanying table lists typical mechanical properties both at room and elevated temperatures in comparison with those of 2218, a standard forging alloy used for elevated temperature applications. While the bulk of test data was obtained from forged specimens, experience on other alloys indicates that the properties are also typical of rolled or extruded products.

The alloy is being offered in the —T6 condition produced by a solution heat treatment and water quench, followed by artificial aging. The —T6 temper is said to provide the best strength for X2219 at 600 F.

The alloy is expected to find wide application in aircraft and automotive engine parts where temperatures reach 500-600 F. Both gas turbine and reciprocating piston engines require aluminum parts which must operate in that service temperature range.



Increasing speeds *of aircraft such as this jet Scorpion make development of higher temperature materials mandatory.*

TYPICAL MECHANICAL PROPERTIES OF X2219 ALLOY

Room Temperature		
	Tentative Guaranteed Min	Typical
Tensile Strength, psi	55,000	62,000
Yield Strength, psi	35,000	43,000
Elongation, % in 4D	6	16

Elevated Temperatures							
		X2219-T6			2218-T6[a]		
Temp of Test.	Time at Temp, Hr	Tens Str, psi	Yld Str, psi	Elong, % in 4D	Tens Str, psi	Yld Str, psi	Elong, % in 4D
500 F	1000	29,000	21,000	24	13,000	9000	50
600 F	1000	18,000	14,000	26	6,000	3500	75
Stress for 0.2% total creep in 100 hr. at 600 F, psi			6700			2300	
Stress for rupture in 100 hr at 600 F, psi			9500			3900	
Fatigue strength, 10^{-8} cycles at 600 F, psi			5500			5000	

[a] *Properties of 2218-T6 Alloy listed for purposes of comparison*

New Materials, Parts and Finishes | and related equipment

New Elastomers from Scrap Rubber

A series of new polymeric materials called Bisonides are being produced by a new process using vulcanized rubber scrap as the basic raw material. They vary from a soft elastomer to a hard tough thermoplastic material and are relatively low in cost. Although the starting hydrocarbon may be natural or GR-S scrap rubber, Bisonides are polar and exhibit properties normally associated with other polar synthetic rubbers. They are curable by a unique mechanism which is said to enhance their possibilities for new types of applications. They have been developed by *U.S. Rubber Reclaiming Co., Inc.*, P.O. Box 365, Buffalo 5, N.Y.

Bisonides are oil resistant and possess good aging properties. They can be cured without sulfur and are compatible with neoprene in all proportions. They offer a variety of possibilities for varying the properties of neoprene while retaining its oil resistance and good aging properties. Bisonides are said to reduce the objectionable tackiness of neoprene compounds at high calender temperatures. They have a stiffening effect and increase the firmness of uncured compounds.

According to the producer, Bisonides have an inherent high cured hardness, a high curing rate and a flat curing range. They show high vibration absorption or damping characteristics. They can be extended with large quantities of oil and are supplied as oil extended polymers when desired. They are compatible with low temperature plasticizers, and consequently are suitable for low temperature applications.

TYPICAL PROPERTIES OF BISONIDES

	Bisonide #400	Bisonide #1600	Bisonide #1630 (Oil extended)*
Forms supplied	Slab or Powder	Slab or Powder	Slab
Plasticity (Mooney) ML/2.2/5-1	40-75	75-125	30-45
Specific Gravity	1.15	1.20	1.17
Rubber Hydrocarbon, %	48-50	45-50	37-40*
Acetone Extract, %	20	25	35
Suggested Uses	All-purpose	Oil resistant compounds	Oil resistant sponge; low temperature stocks; low priced mechanical goods

**Oil extended types are treated as if the rubbery hydrocarbon were 50%*

Where they may be used

Suggested applications for the materials include the following:

1. *Oil resistant compounds* As a partial replacement for original polymers.
2. *Solvent resistant compounds* Especially resistant to chlorinated solvents.
3. *Gaskets* Excellent aging and compatibility with neoprene.
4. *Calender stock* Reduces tack of neoprene at high temperature.
5. *Mechanical goods* High vibration absorption or damping.
6. *Shoe soles and heels* Leathery characteristics, inherent high cured hardness and gravity advantage as compared to neoprene.
7. *Industrial oil-resistant matting.*
8. *Oil extended stocks* Sponge and low temperature stocks.
9. *Structural hard rubber.*
10. *C. V. Wire* Has rapid curing rate.
11. *All-purpose hydrocarbon extender.*

Vitreous Enameled Aluminum Castings

Decorative color effect, surface protection, insulation and impregnation are claimed as features of a new process for applying vitreous enamel to aluminum permanent mold and die castings. Developers of the process, *Monarch Aluminum Mfg. Co.*, Detroit Ave., Cleveland 2, are now supplying customers with castings to which colors such as turquoise blue, hacienda red, pink and yellow have been applied in the form of vitreous enamel. Ultimately there will be additional colors available. The color is light-fast, resists fading and discoloration and will not stain, streak or lose color on exposure to detergents, salt water, mild alkalies or acids. Cooking temperatures or flame will not affect the color.

Normal coatings, ranging from 0.005 to 0.010 in. thick are said to be glass-hard and scratch and abrasion resistant. They are designed to protect the aluminum from wear and corrosion. Since the enamel is a refractory, it can be applied to certain areas to retard surface heat and direct it to other areas. Coatings subjected to 10 F and subsequently oven heated for 2 hr at 400 F showed no evidence of chipping, flaking or lifting of enamel, indicating

Kennametal tools working in a coal mine.

OSTUCO TUBING HELPED BOOST PRODUCTION AND REDUCE DRILLING COSTS

The Problem: Various mining augers originally used with Kennametal Tungsten carbide bits were frequently replaced due to bending and twisting—particularly in hard, fast drilling. This resulted in excessive downtime, and limited potential drilling life of the Kennametal bits . . . which are capable of drilling from 4,500 to 12,000 feet.

The Solution: New Kennametal augers, manufactured from OSTUCO Seamless Steel Tubing, last the life of several bits. These tubular augers have rigidity to stand the high pressure of fast, long-hole drilling, yet are light weight for easier handling underground. Lightness, rigidity and long wear are especially important in drilling holes of 100 feet depths during mining of anthracite coal and gypsum.

Discuss your particular problems with an OSTUCO Tubing Engineer. Then take advantage of OSTUCO's convenient *Single-Source* Service and fill all your tubing needs on one order. Write or call your nearest OSTUCO Sales Office, or write OSTUCO, Shelby, Ohio.

OSTUCO TUBING

SEAMLESS AND ELECTRIC WELDED STEEL TUBING
—Fabricating and Forging

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • **SHELBY, OHIO**
Birthplace of the Seamless Steel Tube Industry in America

SALES OFFICES: BIRMINGHAM • CHARLOTTE • CHICAGO (Oak Park) CLEVELAND • DAYTON • DENVER • DETROIT (Ferndale) HOUSTON • LOS ANGELES (Beverly Hills) MOLINE • NEW YORK • NORTH KANSAS CITY PHILADELPHIA • PITTSBURGH • RICHMOND • ROCHESTER ST. LOUIS • ST. PAUL • SEATTLE • TULSA • WICHITA

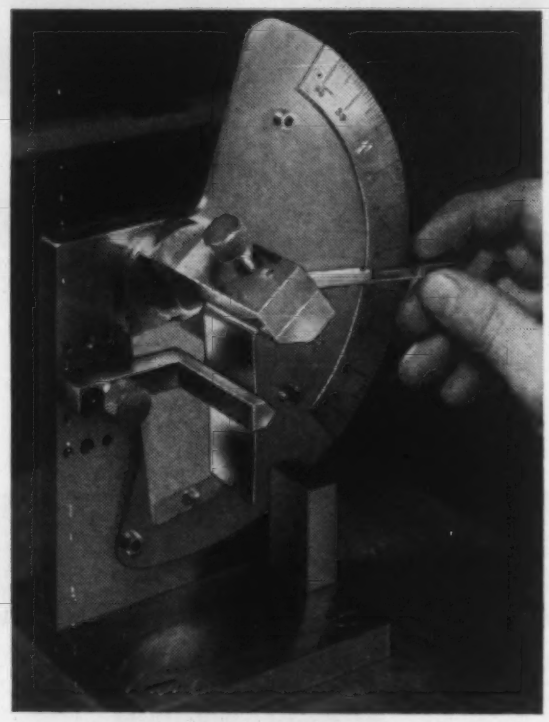
CANADA, RAILWAY & POWER ENGR. CORP., LTD.

EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY
117 Liberty Street, New York 6, New York

For more information, turn to Reader Service Card, Circle No. 366

MONEL • NICKEL • COPPER • ALLOYS
THIN STRIP

no standard
is too exacting



Temper requirements for the thin nickel strip (.002") used in sensitive electronic tubes were too exacting to be checked by the usual methods. So Somers carefully hand checks several samples from each lot by the ultra-precise "bend test" illustrated above.

Since 1910 Somers Brass Company has specialized in producing thin strip: nickel and its alloys below .020" and copper and its alloys below .012" with the tensile properties, fatigue resistance, drawing properties and many other requirements which only the most exacting standards of production and quality control can meet.

Whatever your specifications may be, why not take advantage of Somers long experience? Write for field engineer or Confidential Data Blank for a complete survey of your problem at no cost or obligation.

FOR EXACTING STANDARDS ONLY
Somers

Somers Brass Company, Inc.
WATERBURY, CONN.

For more information, Circle No. 377

New Materials, Parts and Finishes | and related equipment

good thermal shock resistance. A 1200 F flame, directed at the enameled surface for 15 min produced no surface breakdown. As electrical insulation coatings have a voltage breakdown rating of 500 v per mil.

Shapes and finishes

Potentially any surface of an aluminum casting can be enameled by Monarch methods. However, a limitation exists in that the composition of the low temperature frits used prohibits use of enameled surfaces in contact with foods. Vitreous enamel can be applied directly over normal as-cast surfaces; however, preliminary finishing operations can be added if a smoother gloss finish is desired.

At present, initial production operations are being carried out on one general purpose aluminum alloy. Ultimately the company expects to expand the scope of the process to other alloys.

CO_2 Cuts Cost of Shielded Arc Welding

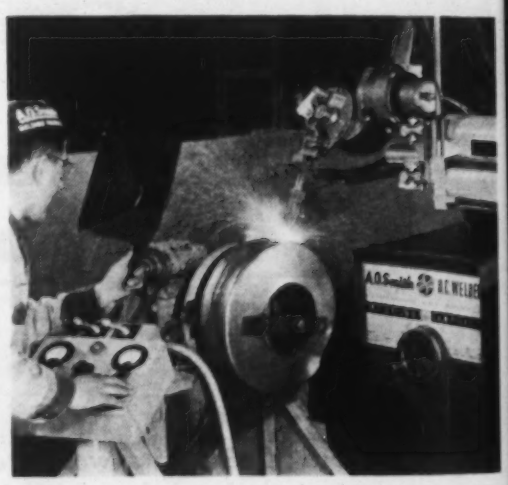
A new automatic welding process known as C-Omatic which uses carbon dioxide gas for shielding the arc while welding mild and medium carbon steel has been developed by the *A. O. Smith Corp.*, Milwaukee 1, Wis. Similar in operation to other shielded inert-gas metal-arc processes, C-O-matic was developed to reduce the cost of this type of welding process to permit its use in fabricating carbon steel products.

Advantages of the process are said to be:

1. Low cost permits use of automatic equipment on mild and medium carbon steels.
2. Visibility of arc at all times permits closer control of welding operation.
3. Cleanliness of weld eliminates slag removal and resultant slag entrapment in weld.
4. Eliminates abrasive powdered flux in welding area, thus averting additional clean-up time and cost.
5. Deep penetration and high metal deposits form an advantage for single-pass welding as used in the process.

Cost reduction

Comparative cost figures for various inert shielding gases per cu ft as well as comparative gas consumption figures per hr illustrate the economies possible.



Carbon dioxide shielding *promises to make economical automatic welding of mild and medium carbon steels.*

Based on use of standard size cylinders, cost of carbon dioxide is approximately $0.01 per cu ft, as compared with $0.06 per cu ft for helium and $0.08 to $0.09 per cu ft for argon. Greater economies are said to be possible when gas is used in larger quantities.

According to A. O. Smith, gas consumption tests have shown that quantity of CO_2 needed is approximately half that needed when helium or argon are used. The Smith process uses 30 cu ft or less of CO_2 per hr while 60 cu ft of argon and 70 cu ft of helium are required for the same purpose.

(More New Materials on p. 142)

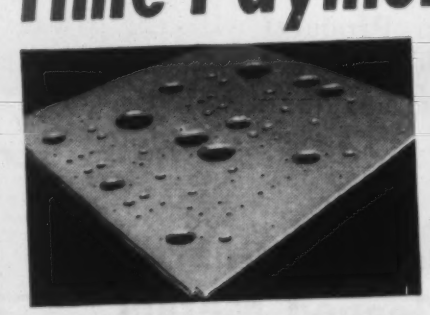
Announcing

PAY-AS-YOU-PRODUCE PLAN

WITH

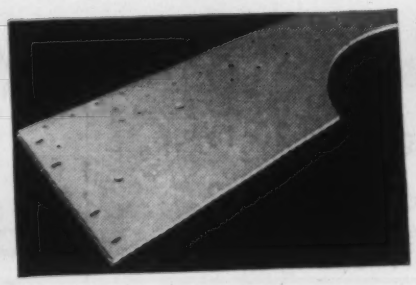
WALES *Fabricators*

Time Payments PAID OUT OF THESE SAVINGS!



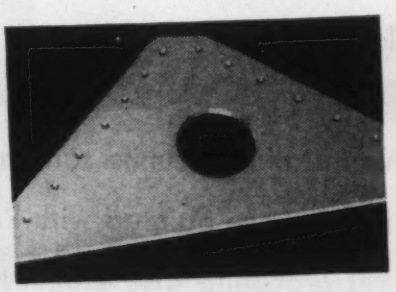
ELECTRONIC CHASSIS 12-1/2" x 11-1/2", with 118 holes and 4 notches was completed including setup in only 32.45 minutes and subsequent pieces in

6.44 minutes.



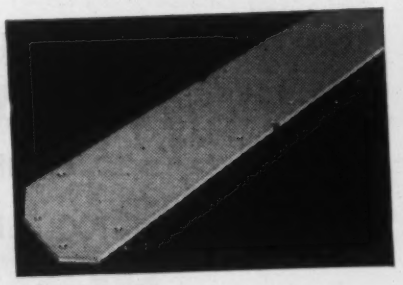
A part of FARM EQUIPMENT, 72-1/2" x 22" with 32 holes and nibbled cut out was finished including setup in only 12.01 minutes, subsequent pieces in

2.32 minutes.



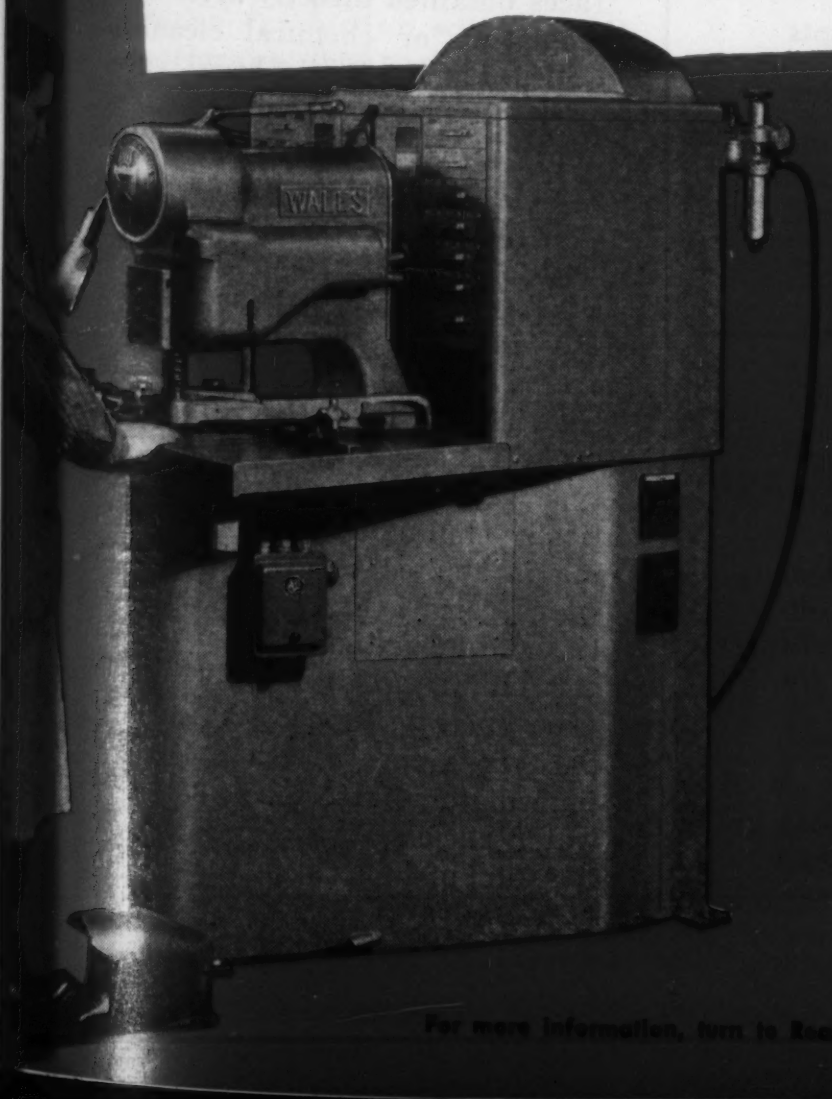
AN AIRCRAFT part 7-1/2" x 4-1/2" with 15 holes and 1 notch was produced including setup in only 3.52 minutes and subsequent pieces in only

54 seconds.



Part of an ELECTRIC REFRIGERATOR, 39-7/8" x 8-1/2" with 10 holes and 4 notches was fabricated including setup in only 5.61 minutes and subsequent pieces in only

37 seconds.



Check the difference between your present methods of production to make the above parts and the typical astounding time studies produced on Wales Fabricators, *the only machine of its kind.*

Designed for rapid interchangeability of punches and dies for hole punching, notching and nibbling operations, Wales Fabricators permit working direct from blueprints or operation sheets . . . *no templates required.*

Write today for complete information on Wales Fabricator Pay-As-You-Produce Plan that more than pays for itself out of savings.

WALES-STRIPPIT CORPORATION

George F. Wales, Chairman

599 Payne Avenue, North Tonawanda, N. Y.

(Between Buffalo and Niagara Falls)

Wales-Strippit of Canada, Ltd., Hamilton, Ontario

Specialists in Punching and Notching Equipment

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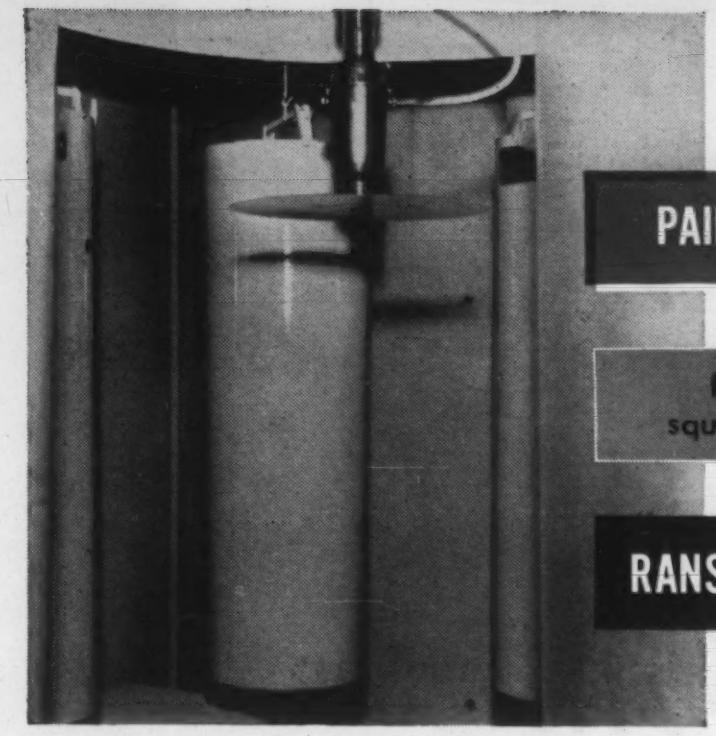


When General Water Heater Corp., in Burbank, Calif., switched from hand spray to Ransburg No. 2 Process in painting water heater jackets, paint mileage increased almost 65%. Where General formerly got 370 square feet per gallon of paint, they now get over 610 per gallon.

On this installation, units ranging from 20 to 100-gallon size are painted with Ransburg No. 2 Process reciprocating disc atomizer. Changes in jacket sizes can be made without stopping the conveyor. With the reciprocating disc atomizer, change in stroke length is made "on the fly" without shutting down production. General also paints smaller parts, such as heater tops, bottoms, doors and legs, with the Ransburg equipment.

In addition to paint and labor savings, General Water Heater is getting "excellent consistency" and a high quality finish on their products. Another on-the-job-example of the unmatched efficiencies of the Ransburg No. 2 Process of electrostatic spray painting!

Ransburg maintains complete laboratory facilities for test-painting YOUR products under simulated production conditions. Why not let us show you what Ransburg Electrostatic Processes can do for you in YOUR finishing department. No obligation.

For further information about Electrostatic Painting Processes and complete Ransburg services, write Dept. M.

Ransburg ELECTRO-COATING CORP.
Indianapolis 7, Indiana
RANSBURG

For more information, turn to Reader Service Card, Circle No. 371

New Materials, Parts, Finishes

New Titanium Alloy Has High Impact Strength

A new titanium alloy has been developed for use in powder metal products by the *Brush Laboratories Co., Div. of Clevite Corp.*, 540 E. 105th St., Cleveland 8, Ohio. Parts produced with the powder are said to have an impact strength of 40-50 ft-lb at room temperature, and a notched fatigue endurance ratio in the range of 28 to 32% at 10 million cycles.

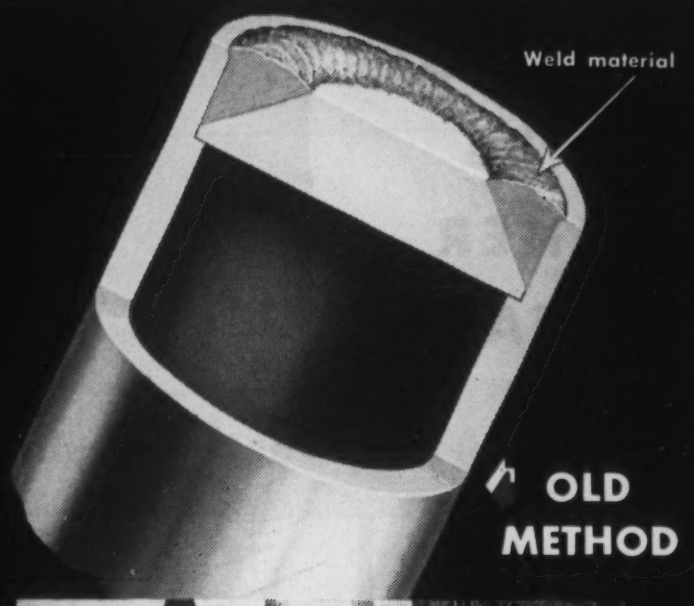
The alloy makes use of small additions of aluminum to replace less desirable interstitial elements such as oxygen, to provide a tensile strength of 65,000 to 85,000 psi. Products with the powder are presently available in limited commercial quantities.

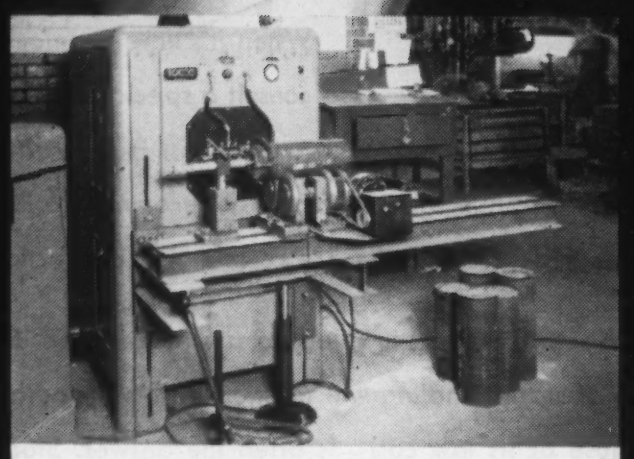
Coating Guards Cleaned Metals

A new coating for metals has been developed which is said to preserve chemically-cleaned surfaces obtained directly after electroplating or chemical cleaning. Called Laqua, it displaces water as it deposits a thin protective film which protects metals from oxidation and attack by salt-spray or other corrosive media. According to the manufacturers, *Fidelity Chemical Products Corp.*, 470-474 Frelinghuysen Ave., Newark, N. J., Laqua-coated parts show no corrosion after 210 hr of an ASTM salt spray test. Fungus-type growth is said to be practically eliminated when the coating is applied to cadmium parts which come in contact with plastics and insulation. Use of Laqua also eliminates drying operations after plating, since the plated part is dipped in the material immediately after a final hot water rinse.

A film of the coating, 0.0001 in.

Production Doubled
Cost Cut 50%
Product Improved...





TOCCO heating station with inductor and fixture for silver brazing cylinder and cylinder cap assemblies.

with TOCCO* Induction Heating

The experience of The Commercial Shearing and Stamping Company, who use TOCCO for silver-brazing hydraulic cylinder assemblies, is typical of the benefits obtained by America's leading metal-working plants who use TOCCO Induction Heating for brazing, hardening, heat-treating, forging and melting operations.

More Production with TOCCO

a. Heating time per piece cut from 15.3 minutes to 2 minutes on 5¼" I.D. cylinder.

b. Machining and cleaning operations, formerly required, are not needed after TOCCO brazing.

Lower Costs with TOCCO

a. Through a reduction in time required for each piece.

b. Through the elimination of scrap and reworks.

c. Because, since TOCCO is automatic, operator need not be trained or especially skilled.

Improved Product with TOCCO

a. Because of better looks and sales appeal.

b. Because distortion is minimized.

c. Because of elimination of field failures due to severe stress pockets.

TOCCO Engineers— can probably find applications in your plant, too, where TOCCO Induction Heating can increase output, cut unit costs and improve your product. Such a survey costs you nothing—and may save you a great deal.

THE OHIO CRANKSHAFT COMPANY

TOCCO

Mail Coupon Today

NEW **FREE** BULLETIN

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Dept. T-7, Cleveland 1, Ohio

Please send copy of "Typical Results of TOCCO Induction Brazing and Soldering."

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Company_____

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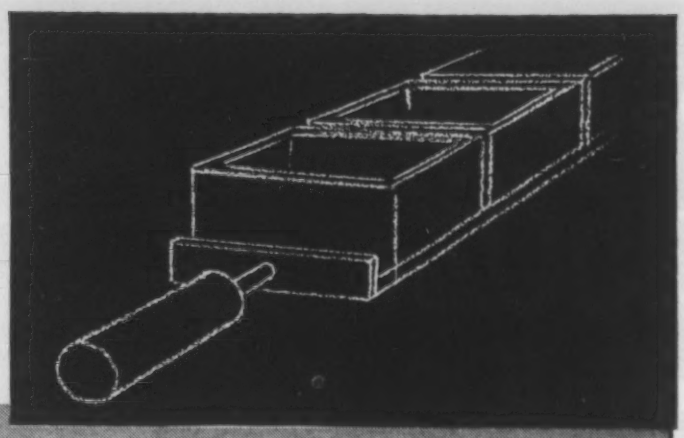
City_____ Zone___ State_____

For more information, turn to Reader Service Card, Circle No. 403

HOLCROFT and the PUSHER FURNACE



An Answer to Stock Handling Problems

When it's time to select a new heat treat furnace, a good move is to consult a specialist—one who understands all phases of the job. Such a specialist is Holcroft. A thorough study of your problem will result in basic recommendations designed to improve quality control—pare costs—give production a lift.

One factor involved in selecting a furnace is the decision as to which type of stock handling will do the job best. A pusher-type furnace—because of its low cost—is often the answer. Stock may be pushed through the heat treat cycles in one of four different ways: on trays, on pusher blocks, in cars, or with one part pushing the other.

Methods of handling stock are discussed in Holcroft's book "Blazing the Heat Treat Trail". It's a good idea to have a copy (just write) in your files. And it's a better idea to call Holcroft when you have a problem. Do it today!

HOLCROFT & CO., 6545 Epworth Boulevard, Detroit 10, Michigan.

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PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE

CHICAGO, ILL. CLEVELAND, OHIO DARIEN, CONN.
HOUSTON, TEXAS LOS ANGELES, CALIF. PHILADELPHIA, PA.
CANADA: Walker Metal Products, Ltd., Windsor, Ontario

For more information, turn to Reader Service Card, Circle No. 450

New Materials, Parts, Finishes

thick has an electrical resistance of 0.2 ohms at 1.5 v and does not interfere with electrical connections, wiring, or parts attached to a chassis that must remain in electrical contact. According to the manufacturers, Laqua coatings improve and speed soldering operations and cadmium plated and aluminum parts can be spot welded without fear of harming the normal strength of the weld. The coating can be stripped from parts with any strong alkaline stripper or cleaner. One thinned gallon of Laqua is said to provide coverage for approximately 800 sq ft.

Top and Bottom Coat for Metallized Plastics

Two new chemically compatible lacquers have been developed for use in metallizing polystyrene plastics. Developed by *Schwartz Chemical Co., Inc.*, 326 W. 70th St., New York, the coatings are said to be tough, flexible and non-flaking. The base coat lacquer, designated BC-107, prepares the surface of plastics for permanent metallic deposition by providing a smooth, glossy finish that fills and covers all cracks. It can be force-dried in 1 hr at 150 F, and, according to the manufacturer, has good adhesion. It will not craze or embrittle after the metal is deposited and the top coat applied.

The top coat is a clear, water-white lacquer designated TC-101. According to the company, it provides a tough protective coating with high gloss, adhesion and permanent flexibility. The lacquer is said to prevent thin silver or aluminum film from flaking, protect it from abrasion and give it a lustrous finish. The coating can be force-dried in about 30 min at 150 F. Both bottom and

Why

buy plated parts . . . when stainless steel fabricated parts cost no more?

Sound fantastic? It really should be. But Bishop's "Tube Mill Pre-fabricated tubular parts" give you major savings that permit you to buy stainless steel at about the same price as a plated part.

Think what this means! Better, longer-lasting, non-corrosive parts . . . increased quality that will give your product extra sales appeal . . . and durability for extra years of service.

These savings are made possible because Bishop, one of America's leading re-drawers of stainless steel tubing, is the *only* mill that makes a specialty of precision fabricated tubular parts.

"Under one roof" redraw and fabrication facilities mean savings in time, transportation and handling costs . . . savings that are passed on to you in lower per unit costs.

And all Bishop "pre-fabricated" parts are made from Bishop-drawn stainless steel tubing . . . the tubing of quality-conscious buyers.

On your next order, why not compare price tags? Send your prints and specifications, or let our engineering department design to fit your needs. Quotations will be returned promptly.

Whether stainless steel tubing or stainless steel tubular parts, you can't buy better than Bishop.

Catalog on Request

THE ONLY REDRAW MILL THAT SPECIALIZES IN PRECISION FABRICATED TUBULAR PARTS

Platinum and Platinum Group Metals
Stainless Steel Tubing
Tubular Fabricated Parts
Spinnerettes
Hypodermic Needles and Syringes

J. BISHOP & CO. • Platinum Works

STAINLESS STEEL DIVISION, MALVERN, PENNA.

For more information, turn to Reader Service Card, Circle No. 308

WHO USES MAGNESIUM?

...and why

Look for the product that's out front in its field . . . and you know *who* uses magnesium! Why? . . . because design engineers and manufacturers alert to today's market conditions are quick to realize the added sales advantages of the product *made of magnesium*. Lightest of the world's structural metals, magnesium can be cast, formed, extruded, drawn or worked into virtually any size or shape! A *modern* metal in every sense, its lightness, strength and weight-saving characteristics are without equal. Even more important are the cost-savings to be gained in many areas of manufacture. The use of magnesium frequently results in *lowered* tooling costs—savings in machining, fabrication and processing costs—and reduced handling and assembly costs!

Magline Inc. has assisted many leading companies in developing better products through the application of magnesium. Magline engineers are qualified by years of experience in this specialized field, and can assist you with design and technical problems. Magline facilities are extensive and complete—from foundry . . . to fabrication . . . through final assembly! For quality production—short or long runs —you can depend on Magline for prompt service and delivery.

Send us part prints of your current requirements for quotation, or write today for your copy of Bulletin No. 50. Your request will receive immediate attention.

MagLine

fabrication facilities for

- Forming
- Machining
- Welding
- Stamping
- Spinning
- Deep Drawing
- Polishing
- Finishing
- Stress Relieving
- Assembly
- Impact Extruding

foundry facilities for

- Sand Castings
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Design and Engineering Services Available

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CANADIAN FACTORY: MAGLINE OF CANADA LTD., RENFREW, ONTARIO.

For more information, turn to Reader Service Card, Circle No. 372

New Materials, Parts, Finishes

top coats can be applied by dipping or spraying and are available, ready-to-use, in 5 or 55 gal containers.

Tempered Beryllium-Copper Wire

Silvercote, tempered beryllium-copper alloy wire, has been developed to eliminate the need for heat treating wire after forming. The spring characteristics of beryllium-copper wire are well known; however, it has been difficult or impossible to use for some applications because of the impracticability of heat treating the wire after it was formed into the desired shape. *Little Falls Alloys, Inc.*, 189 Caldwell Ave., Paterson, N. J., has developed Silvercote wire, which has an ultimate tensile strength of 185,000 psi, yet is ductile enough to wrap around its own diameter. The wire is treated with a process combining heat treatment and cold working. It has high strength and corrosion resistance, good electrical conductivity, is non-magnetic, has high fatigue qualities and comes finished with a silver plate providing ease of solderability and low resistance electrical contact. It can be formed into springs, wire rope and complex shapes.

New Cast Irons Have Improved Properties

A new group of alloy cast irons known as Rezistan irons have been developed by *Uniworld Research Corp. of America*, 1302 Ontario St., Cleveland 13. Combining chromium, nickel, copper, molybdenum and aluminum in a variety of compositions permits a wide range of properties to be obtained. According to Uniworld, the alloys offer a combination of high tensile strengths, impact strengths and wear resistance together with high corrosion resistance, particularly against certain atmospheric conditions, dilute

the class leader

...and with high speed steels

REX is first in its class

Outstanding achievement! That's the only way a product can earn the reputation of being "first in its class." And REX®, as the recognized leader in high speed steels, is no exception.

In thousands of tool shops . . . in every type of application – Crucible REX high speed steels have proved their superiority for over half a century. But it's performance in *your* shop that counts! Try REX on your next job. Test it for size, structure, response to heat treatment, fine tool performance. And you, too, will say REX is *first in its class.*

REX is made only by Crucible. It's available immediately from local Crucible warehouses . . . or by prompt mill delivery. To find out about REX and the many other types of Crucible special purpose steels, write today for "Crucible Publication Catalog." *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

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an ACCO product

Wilson "Rockwell"* Hardness Testers

SET-O-MATIC* DIAL GAUGE

Eliminates human error. Operator merely applies minor load and taps depressor bar. No setting of dial to zero.

OTHER FEATURES

- Major load applied under dash pot control
- Illuminated Dial Gauge
- Major load removed by motor
- Illuminated Penetrator

Eliminates Operations... Increases Tests per Hour

All you have to do with the Model Y WILSON "ROCKWELL" Motorized Hardness Tester is apply the minor load and tap the major load depressor bar. The machine does everything else automatically. The cycle of Major Load operation may be less than 2 seconds.

This speed of test means great savings in time which will reduce your hardness testing costs. Yet it is done to Wilson's high standard of accuracy.

The utter simplicity of setting the SET-O-MATIC* dial gauge eliminates human error. The operator does not have to set the dial. The large pointer is automatically brought to "SET" position when the minor load is applied.

The Model Y Motorized WILSON "ROCKWELL" Hardness Tester is in production and orders are being accepted for early delivery. Write today for descriptive literature and prices.

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New Materials, Parts, Finishes

acids and other chemicals. The improved tensile and impact strength allow reduction in weight of castings as compared to conventional cast iron without detriment to constructional strengths.

Applications for Rezistan Irons include castings for use in the chemical, oil, paper and pulp industries, in production of pumps, compressors, valves and combustion cylinders.

Aluminum-Filled Epoxies for Tooling, Potting

Two aluminum-filled epoxy compounds have been developed for use in tool fabrication or as potting compounds. One is designed to cure at room temperature, the other requires an oven-cure. Developed by *Smooth-On Mfg. Co.*, 570 Communipaw Ave., Jersey City, the resin compounds are machinable by conventional methods, mix easily with curing agents and flow readily into complicated molds and patterns for good reproduction. Curing is by chemical action and shrinkage is less than 0.3%.

Curing requirements

Metalset A306 cures to a tough solid at room temperature in 2-24 hr, depending on size and shape. Metalset A305 requires heat curing, which provides high hardness and sufficient heat resistance for forming operations up to

DREVER

Moly Wound Furnaces

for heating up to 3000 °F

20-KW Muffle Furnace and
300 CFH Ammonia Dissociator

Drever alundum muffle furnaces with molybdenum wire heating elements are ideally suited for heat treatment in hydrogen and/or dissociated ammonia atmospheres.

Furnace shown above has working dimensions of 6½" wide x 5¼" high x 32" long with 52" long water jacketed cooling chamber.

DREVER COMPANY

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27

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Get TEFLON® that behaves as it should

Did you know that Teflon comes in various "grades"? Grade is governed by processing method and by purity. When you get the right grade for the job you will benefit by consistent performance from Teflon.

Premium grade is derived from virgin Teflon. That's what you get with *"electrical grade"* Fluoroflex-T. Conformance to important properties is *certified.** Its non porosity and optimum tensile strength assure reliability in even the most exacting service.

Economy is achieved without impairing chemical inertness in *"mechanical grade"* Fluoroflex-T. Some physical features of this reprocessed Teflon are even improved, since it offers better resistance to elongation with better dimensional stability the result.

In addition, *uniformity* of both grades is assured by a quality control system approved by the USAF under MIL-Q-5923, and by relieving of internal stresses in Fluoroflex-T rods, sheets, tubes and parts.

Send for more data – and for quotations on your needs.

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CORPORATION • Belleville 9, New Jersey

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For more information, turn to Reader Service Card, Circle No. 351

New Materials, Parts, Finishes

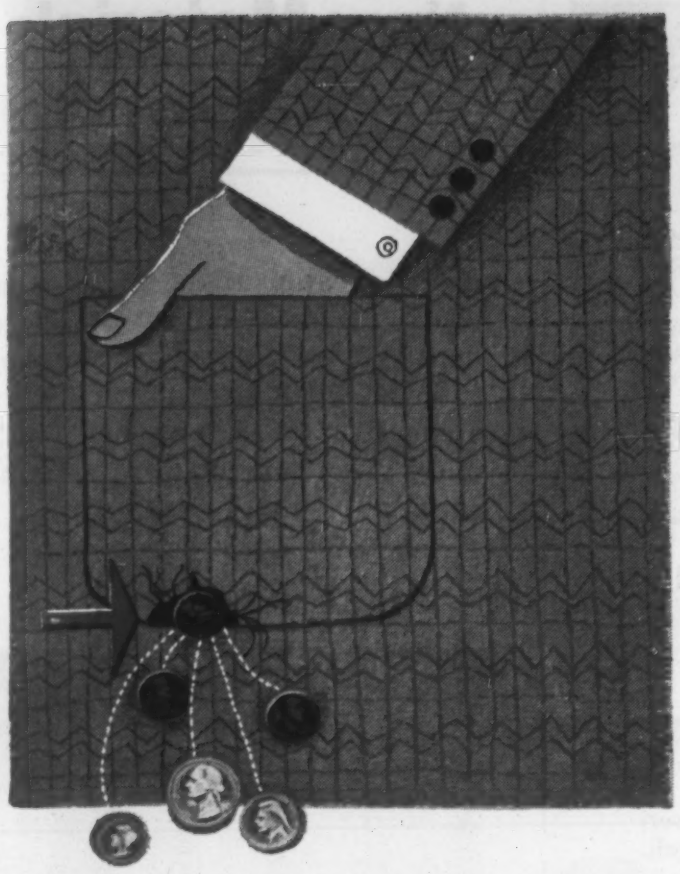
250 F. The materials are designed for use in making pattern duplicates, jigs and fixtures and dies for forming, drawing and trimming. A306 forms an effective potting compound. Both compounds are unaffected by water and resist alkalis and acids.

New Stainless Wire Has Improved Workability

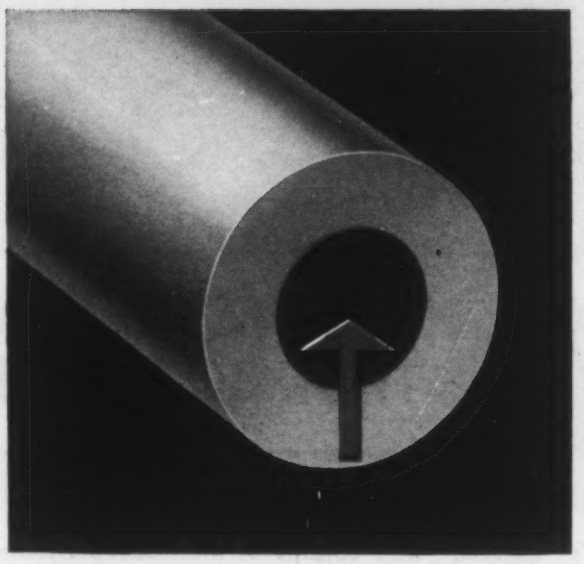
A new type 302 stainless steel wire with a more restricted analysis range has been developed primarily for use in spring production by *Webb Wire Div., the Carpenter Steel Co.*, New Brunswick, N. J. Known as Blue Label Stainless, the wire is said to have improved corrosion resistance, coiling properties and ability to take sharp bends. The wire is also said to have a high degree of uniformity of temper from coil to coil and is suitable for all types of wire forms as well as springs. It is purported to have long fatigue life in springs, and cost is similar to that of standard Type 302 stainless wire.

Vitreous Enamel Frit for Aluminum

A non-toxic, chemically resistant vitreous frit for porcelain enamel, which can be fused to aluminum and its alloys, has been marketed. The lead free frit, now available in pilot-plant quantities for evaluation, was developed by *Minnesota Mining and Mfg. Co.*, 900 Fauquier St., St. Paul 6, Minn. Developed primarily as a decorative finish for aluminum, initial field tests indicate that porcelain enamel made with the new frit is non-toxic, will not flake or chip when cut or sawed, retains its gloss under weathering, resists abrasion, protects against corrosion, can be sprayed or dipped, and can be produced in a variety of colors. It is said to



a hole here costs money...



a hole here saves money

Crucible Hollow Tool Steel Bars put savings into the pockets of the metalworking industry. There's no need for costly drilling, boring, cutting-off or rough-facing operations. For the hole is already in the steel you buy. You save production time, machine capacity—avoid scrap losses.

Crucible Hollow Tool Steel Bars are now available in any of our famous tool steel grades . . . in almost any combination of O.D. and I.D. sizes. And you get *immediate* delivery of five popular grades — KETOS oil-hardening, SANDERSON water-hardening, AIRDI 150 high-carbon high-chromium, AIRKOOL air-hardening, and NU DIE V hot-work tool steels.

Your Crucible representative can show you how to save time and money with Crucible Hollow Tool Steel Bars. *Crucible Steel Company of America, Oliver Building, Pittsburgh 30, Pa.*

CRUCIBLE first name in special purpose steels

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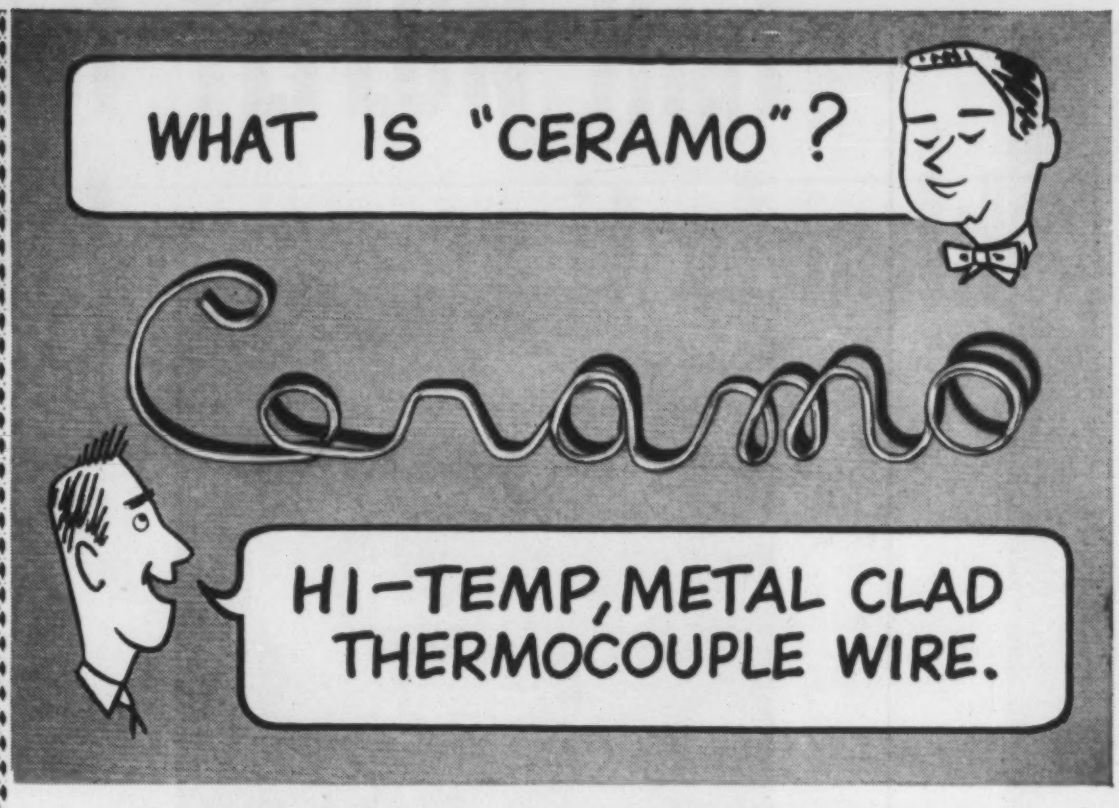
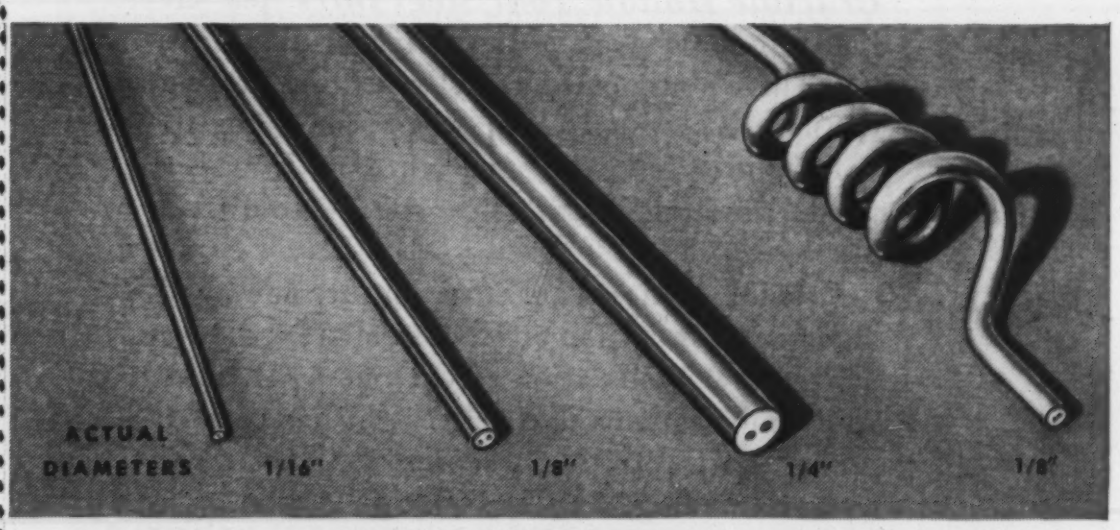


T-E's "Ceramo" wire consists of thermocouple material conductors, surrounded by magnesium-oxide insulation, with seamless metal tubing overall.

Thermocouples or extensions made of "Ceramo" wires will fit into openings that are too small for most ordinary thermocouples or extensions. Furthermore, they can be formed easily to any configuration without short-circuiting—in fact, "Ceramo" can be bent on a radius as small as its own diameter. The durability of the outer metal tube makes conduits unnecessary. Not even a hammer blow will injure it; in fact, it will withstand pressures up to 40,000 psi. These metallic clad wires have excellent resistance to high temperature, moisture, chemicals, petroleum products, atomic radiation or abrasion.

"Ceramo" thermocouple wires are made in Iron-Constantan, Chromel-Alumel, Copper-Constantan, Chromel-Constantan, and Platinum-Rhodium Platinum. Wires are sheathed with seamless tubing of stainless steels, Inconel, aluminum, or copper. Made with 30, 22 and 16 gage conductor material; overall diameters of 1/16", 1/8", and 1/4" respectively; lengths up to 30 ft.



"Ceramo" thermocouple extension wires are made in Iron-Constantan, Chromel-Alumel, or Copper-Constantan with copper-nickel alloy, plain or galvanized cold drawn steel sheath overall. Made with 20 and 16 gage conductor material; overall diameters of 1/8" and 1/4" respectively; lengths up to 2000 ft., depending on the type of metal tubing and outside diameter. "Ceramo" is made also in single conductors or multiconductor cables.

Interested? Write for bulletin 31-300 -G.

Pyrometers • Temperature Monitoring Systems • Thermocouples • Protection Tubes
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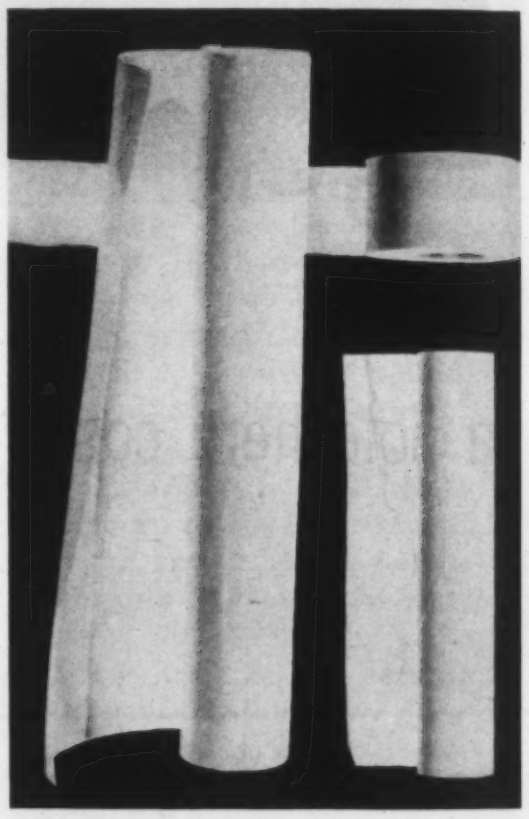
IN CANADA—THERMO ELECTRIC (Canada) Ltd., BRAMPTON, ONTARIO

For more information, turn to Reader Service Card, Circle No. 324

New Materials, Parts, Finishes

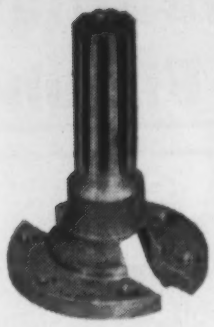
cover greater areas per lb than other enamels due to its lower density. Anticipated uses include interior and exterior porcelain enamels used on household appliances and finishes for aircraft, cars, ships and boats.

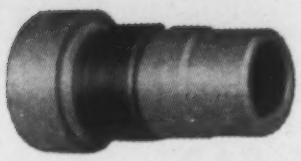


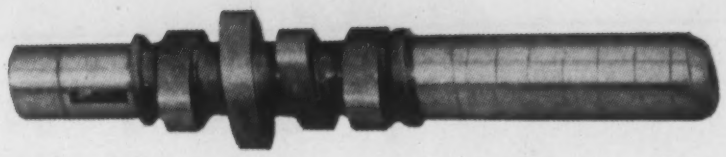
Teflon Tape Produced 24 In. Wide

Kelon-T (Teflon) tape is now being produced in widths up to 24 in. and in thicknesses varying from 0.005 to 0.125 in. in continuous lengths by *W. S. Shamban & Co.*, 11617 W. Jefferson Blvd., Culver City, Calif. Nonadhesive and chemically inert, the tape combines toughness, excellent electrical properties and resistance to abrasion and corrosive chemicals at high and low temperatures. Its good elongation permits fitting tightly over sharp bends and corners, and Teflon's elastic memory aids its return to original shape upon heating.

With uniform dielectric constant and power factor over a wide frequency range at temperatures of -300 to 300 F, the tape is suitable for electrical applications

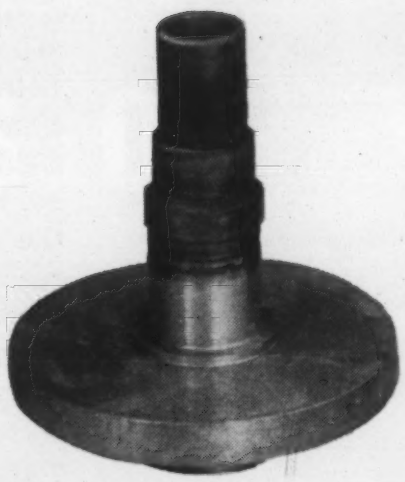


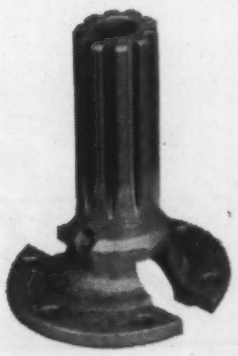




what's new ?

NUMBER 32 OF A SERIES





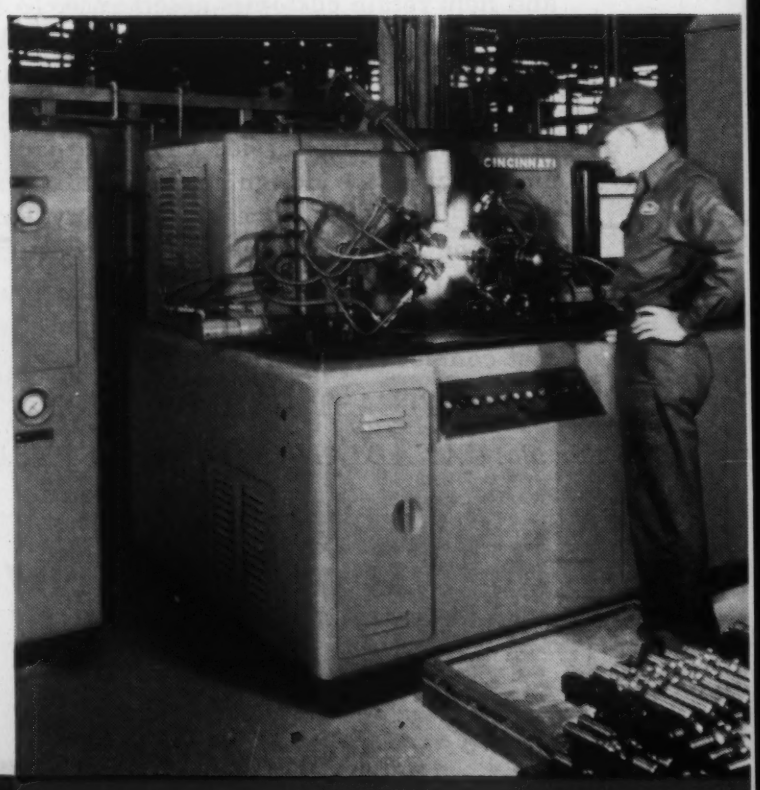
seven hardening jobs on one flamatic

You might look for a lot of fancy tooling on the Standard Flamatic that hardens all these jobs. You won't find it.

Instead, you'll find a single, work-holding fixture and two pairs of standard flame heads, changed over in minutes to switch from one job to the next. These parts are made by a manufacturer of automotive transmissions whose schedules and varying lot sizes make the heat treating virtually a job-shop operation.

Flamatic keeps the pace, maintains part-to-part uniformity, holds costs in line, and gives the maintenance people practically no trouble. Flamatic holds temperatures in line with electronic control, operation is pushbutton except for loading.

To find out how versatile Flamatic selective hardening can be, write for Publication No. M-1861.



CINCINNATI **flamatic**

PROCESS MACHINERY DIVISION
THE CINCINNATI MILLING MACHINE CO.
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Accuracy cuts cost.
Less than 1 hour machining time is required per unit assembly with Unitcastings.

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..ADD UP TO TOP QUALITY PRODUCT!

A nationally known manufacturer of house trailer tow-bar mechanisms keeps quality up and costs down by specifying *Unitcastings*. Dimensional accuracy, internal soundness and good surface appearance hold finishing costs to a minimum and help retain customer acceptance. In less than six years of production and over 202,000 parts later, less than ½ of 1% of the total castings shipped have been returned for any reason.

Beginning with the original design of the castings, Unitcast's engineering service has kept pace too, by continually modernizing the design to suit automobile chassis improvements. This is just one of the many Unitcast Foundry Engineering Services available to our customers.

Let Unitcast help you modernize your product by including foundry standards in the design. Keep your production cost competitive. . .write today!

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QUALITY STEEL CASTINGS

For more information, turn to Reader Service Card, Circle No. 429

New Materials, Parts, Finishes

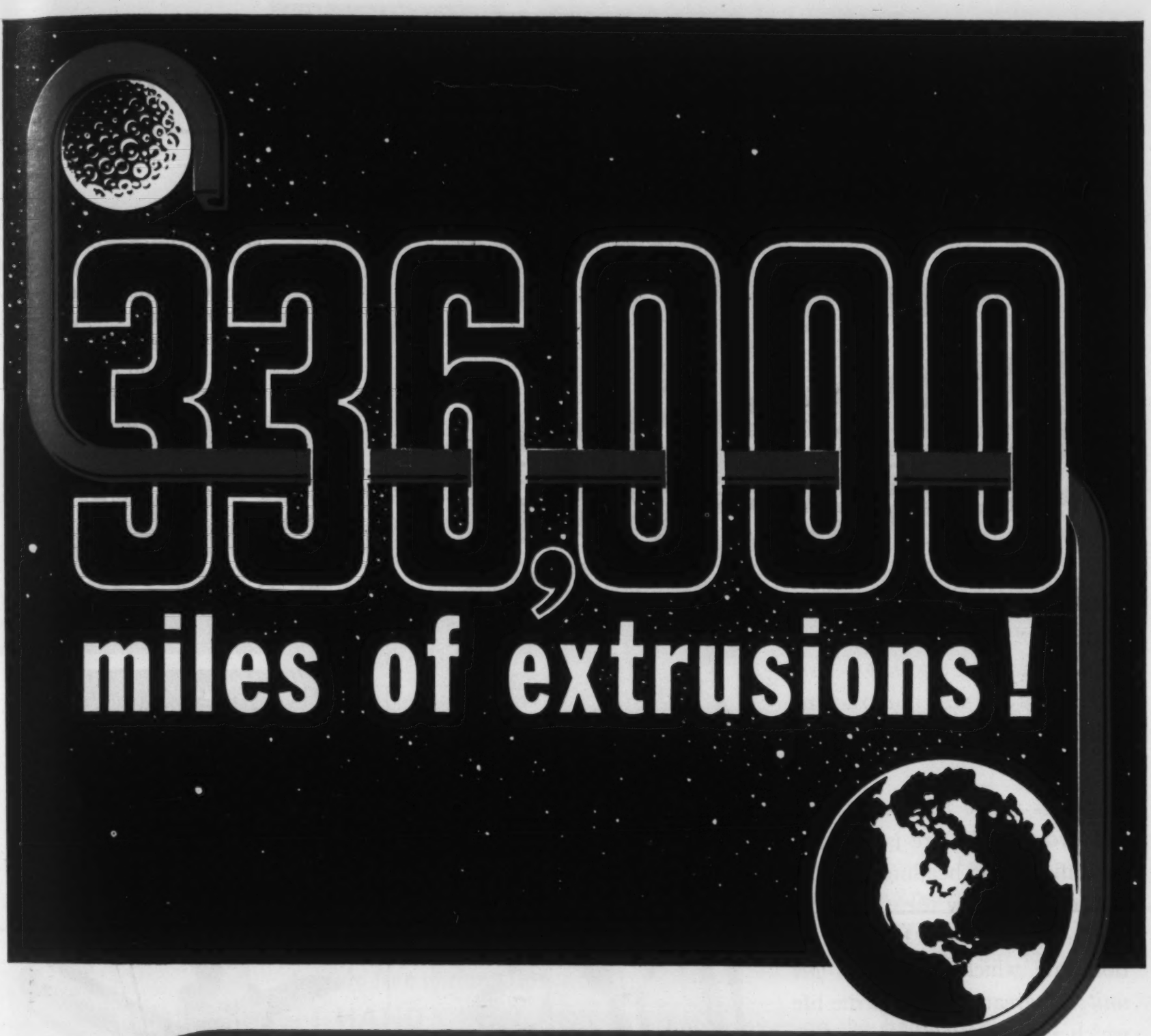
requiring non-sticky surfaces. Suggested applications include motor-slot lining, cable wrapping, capacitor dielectric, coil wrapping and gasket shielding for corrosive chemicals.

Flame Sprayed Ceramics

A method for coating a variety of substances by feeding powdered ceramic materials through a simple flame gun has been developed by Armour Research Foundation and licensed to *Continental Coatings Corp.* of Ill., 2333 S. Michigan Ave., Chicago 16. Called Flame Spray Ceramics, the application technique closely resembles normal metallizing processes. The coatings consist of sintered layers of refractory and chemically inert materials, such as aluminum oxide or zirconium oxide. Spray coatings do not require that the metal or other base be unduly heated, permitting successful coating of low temperature materials such as aluminum. The aluminum oxide coating is harder than tool steel and adherent in thicknesses up to about 10 mils. Heavier coatings may contain residual stresses which could cause coating failure on sudden heating or cooling.

Applications

Hardness of the coatings suggests their use for protecting soft metals such as aluminum, die-cast alloys or mild steel, against erosion and abrasion in pump impellers and housings, fan blades and turbines, and piping subject to cavitation. Alumina coatings are electrically insulative, and use is anticipated in manufacture of high temperature process equipment. Zirconia coatings, which are softer and more difficult to apply, have exceptional resistance to corrosion and heat. Use is expected in rockets, flame ducts, burner equipment, and as a liner



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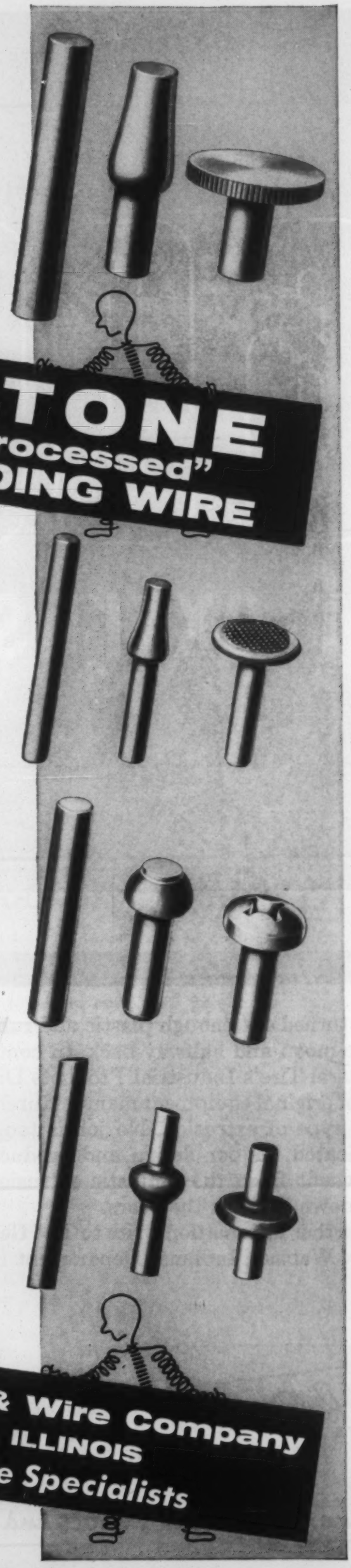
Wire that's *BEST* for difficult cold heading



The terrific displacement of metal during the cold heading process requires a wire that's *processed specifically* to meet the exact requirements of the job.

In plants where Keystone "Special Processed" Wire is specified for difficult cold heading, production records show these valuable results: (1) increases the production rate which *lowers cost per unit;* (2) greatly prolongs die life which *reduces machine down-time and labor costs;* (3) provides higher quality finished products which *minimizes rejections and inspections.*

Call on our wire specialists for assistance on any problem concerning steel wire. Contact your Keystone representative or write direct.

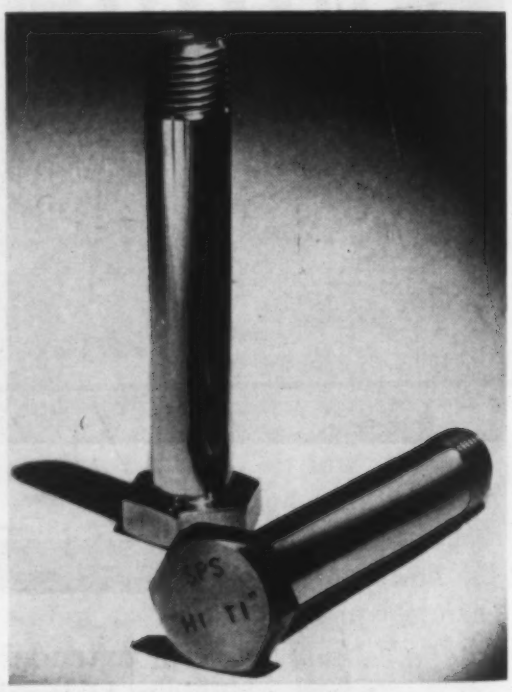
Keystone Steel & Wire Company
PEORIA 7, ILLINOIS
Industrial Wire Specialists

For more information, turn to Reader Service Card, Circle No. 413

New Materials, Parts, Finishes

for rough feeders, molds and other foundry equipment.

Though corrosion resistance of the ceramic materials is high, like all sprayed coatings, Flame Spray Ceramics have residual porosity of about 10-15% and alone do not provide perfect protection against chemical corrosion of underlying materials. However, various additives to the two basic coatings improve their protective action, and this can be improved further by overcoating with solution ceramics or by co-spraying with soft metals.



Titanium Shear Bolts Cut Assembly Weight

The weight-saving potentials of titanium have been realized in another specific fastener application by the development by *Standard Pressed Steel Co.*, Jenkintown, Pa., of titanium shear bolts. Major application would seem to be in the aircraft industry where weight reduction is at a premium, and where a majority of threaded fasteners are subjected to shear loading. Hi-Ti titanium shear bolts (Type NAS 464) are said to meet new standards for titanium shear bolts now being developed by the aviation industry. These standards establish minimum tension fa-

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Murray-Way's New #55 Head

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GUARANTEED SPINDLES—All Murray-Way 55 Spindles are GUARANTEED FOR 3 YEARS. Factory-tested spindles incorporate heavy-duty, anti-friction bearings that require no grease or oil and are sealed against dirt for trouble free performance.

RIGHT OR LEFT HAND OPERATION—By simply inverting the head assembly, the 55 Heads may be used for either right or left hand operation.

SMALL FLOOR SPACE—The 55 Series Heads will install in line on 5′8″ centers. They conserve floor space, economize on conveyors, and reduce fixture requirements.

UNIVERSAL POSITIONING—With the Murray-Way adjustable fulcrum head, you get universal positioning by means of simple, accessible adjustment controls at the front of the head.

RUGGED—These heads are truly heavy-duty workhorses with 30 H.P. capacity.

FULL WORK CONTACT—On even the most irregular work shapes, Murray-Way's 55 Heads remain in constant contact—NO EXTRA PASSES—LOWER OPERATING COST—MORE PRODUCTION.

The technical know-how of Murray-Way's experienced engineers is the reason that production men who want a BETTER WAY . . . SPECIFY MURRAY-WAY.

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New Materials, Parts, Finishes

tigue requirements, necessary because of the notch sensitivity of titanium alloys. Tension-fatigue tests indicate that ¼-in. Hi-Ti shear bolts withstand a load of 60,000 psi after stressing for 8 million load cycles.

According to the manufacturer, the bolts exceed minimum shear requirements of 95,000 psi for steel aircraft bolts. The ¼-in. Hi-Ti bolts have a shear strength of 109,200 psi, the ½-in. bolts have a shear strength of 112,000 psi. While presently publishing data on the ¼ and ½-in. bolts, SPS indicates that it is prepared to produce bolts in sizes ranging from No. 10 up through ½-in. diameters. Fatigue data will be provided with every lot of bolts shipped.

New Copper-Colored Porcelain Enamel

A new porcelain enamel finish for steel which is said to combine the beauty of copper with the durability of porcelain enamel has been developed by *Pemco Corp.*, 5601 Eastern Ave., Baltimore 24, Md., in cooperation with Samuel Stamping and Enameling Co. Called Coppertan, it is said to be resistant to tarnishing, scratching and acid attack. It can be formulated to provide either a gloss or satin finish.

To produce the finish, a light colored base of Titania covercoat enamel is first applied over fired groundcoat enamel. While this is still wet, shading is over-sprayed in any desired pattern. The shading is made of a clear acid-resistant covercoat enamel which is a darker color than the base enamel. A lacquer gun with a fine tip and needle produces a satisfactory shading. The coating is then fired in a furnace at 1500-1520 F for 3 min, or as required. The frit, clay, opacifier, and coloring oxides required to produce the finish are available from Pemco.

The finish is designed for use

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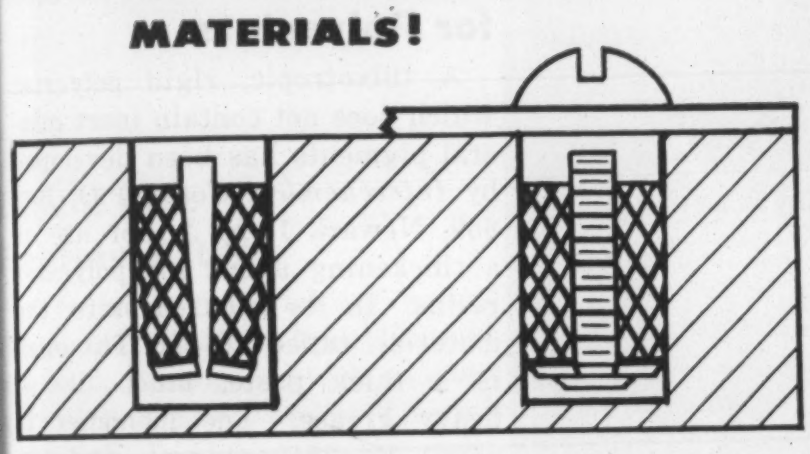

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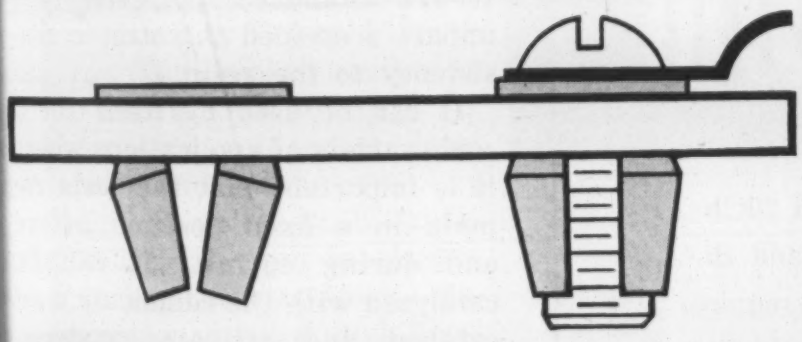

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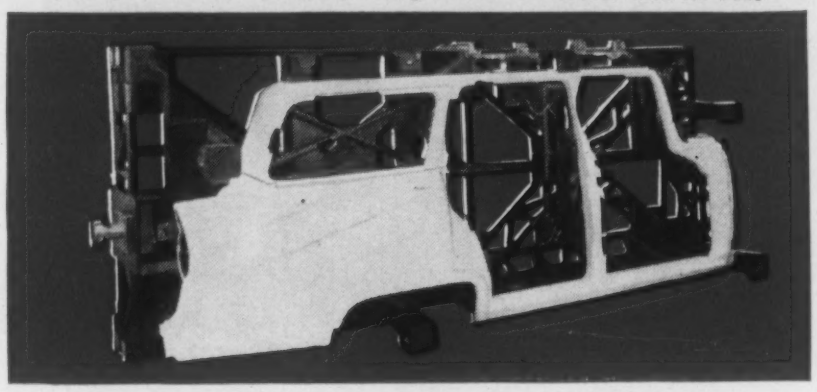

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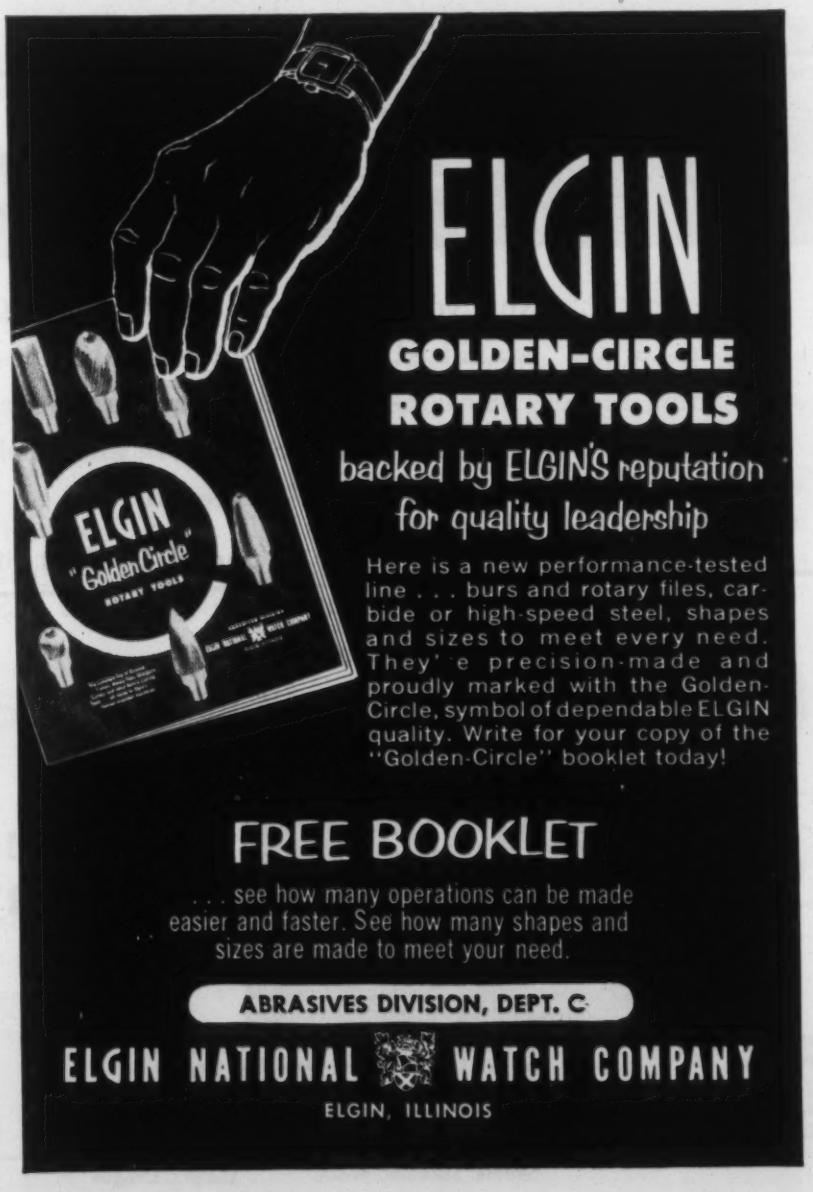

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New Materials, Parts, Finishes

on kitchen ranges, other home appliances, air conditioners, cooking utensils, commercial refrigeration equipment, garbage disposals, dishwashers, heating equipment, metal kitchen cabinets, portable grills, soda fountains, sinks and similar types of equipment.

Thickening Agent for Polyesters

A thixotropic, rigid polyester which does not contain inert mineral pigments has been developed by *Interchemical Corp.*, P.O. Box 659, Newark 1, N. J., for use as a thickening agent for polyester resins. In its uncured state, the material, called IC-480 Thixogel, is a thick paste, much like a heavy grease. The monomer is nominally 25% styrene, and the cured material has a Barcol hardness of 45-50. Between 10 and 20% of the material added to IC-312 Standard polyester will impart a decided thixotropic consistency to the resin.

It can be used by itself for a wide variety of applications where it is important that the resin remain in a fixed position before and during curing. It can be catalyzed with the commonly used catalyst and activator systems.

Close Tolerance Acrylic Sheet

Cast acrylic sheet with closer than usual thickness tolerances is now available from *Cast Optics Corp.*, Hackensack, N. J. Sheet is being produced in thicknesses ranging from 0.020 to 1 in. Thickness tolerances on $\frac{1}{8}$ in. sheet are held to $\pm$ 0.006 in.

Cast acrylics are used for a wide variety of industrial, manufacturing and military applications. Closer thickness tolerances are expected to be useful in such applications as instrument glaz-

ing and other air- and dust-proof glazing applications, since a better seal can be obtained.

Cast Optics Corp.'s acrylic sheet has good hot forming qualities and can be blown or deep drawn. Sheet surfaces are said to be comparable to the surfaces of the polished plate glass molds from which they are cast. The water white material has high impact resistance and has been compounded to ensure maximum abrasion resistance.

Liquid Tile Resists Attack

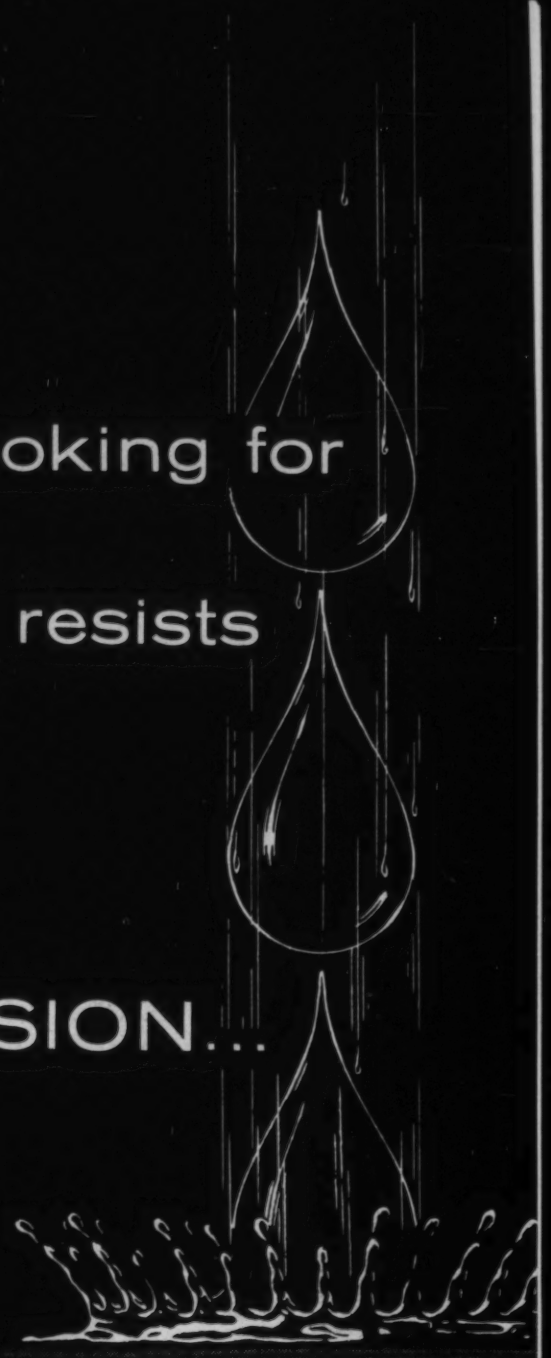
A finishing material for walls, floors and concrete tank linings has been developed which can be applied like paint, and will form a smooth, hard waterproof surface. Manufactured by *Ev-R-Shield Products, Inc.*, Joppa, Md., the material, called Glascote, is based on a thermo-setting plastics resin produced by Reichold Chemicals, Inc. The finished surface is said to be resistant to attack by acids, caustics, salt water, alcohol, grease and boiling lye.

It can be applied with brush, spray, roller or swab to plaster, sheet rock, concrete, brick, masonite, seasoned wood and fiberboard. According to the manufacturers, application requires no special measuring or heating for curing. It is self-leveling and a hardener mixed into the material generates enough low heat to bake the material during final cure. The finish is pore-less and surfaces cannot yellow, discolor or fade.

Glascote can be applied directly over water-mixed paints, though oil-base paints usually must be removed. The finish cannot be used on such nonporous materials as metal, porcelain or ceramic tile. A gallon is said to cover 300 to 400 sq. ft.

(More New Materials on p. 162)

For more information, Circle No. 379 ➤



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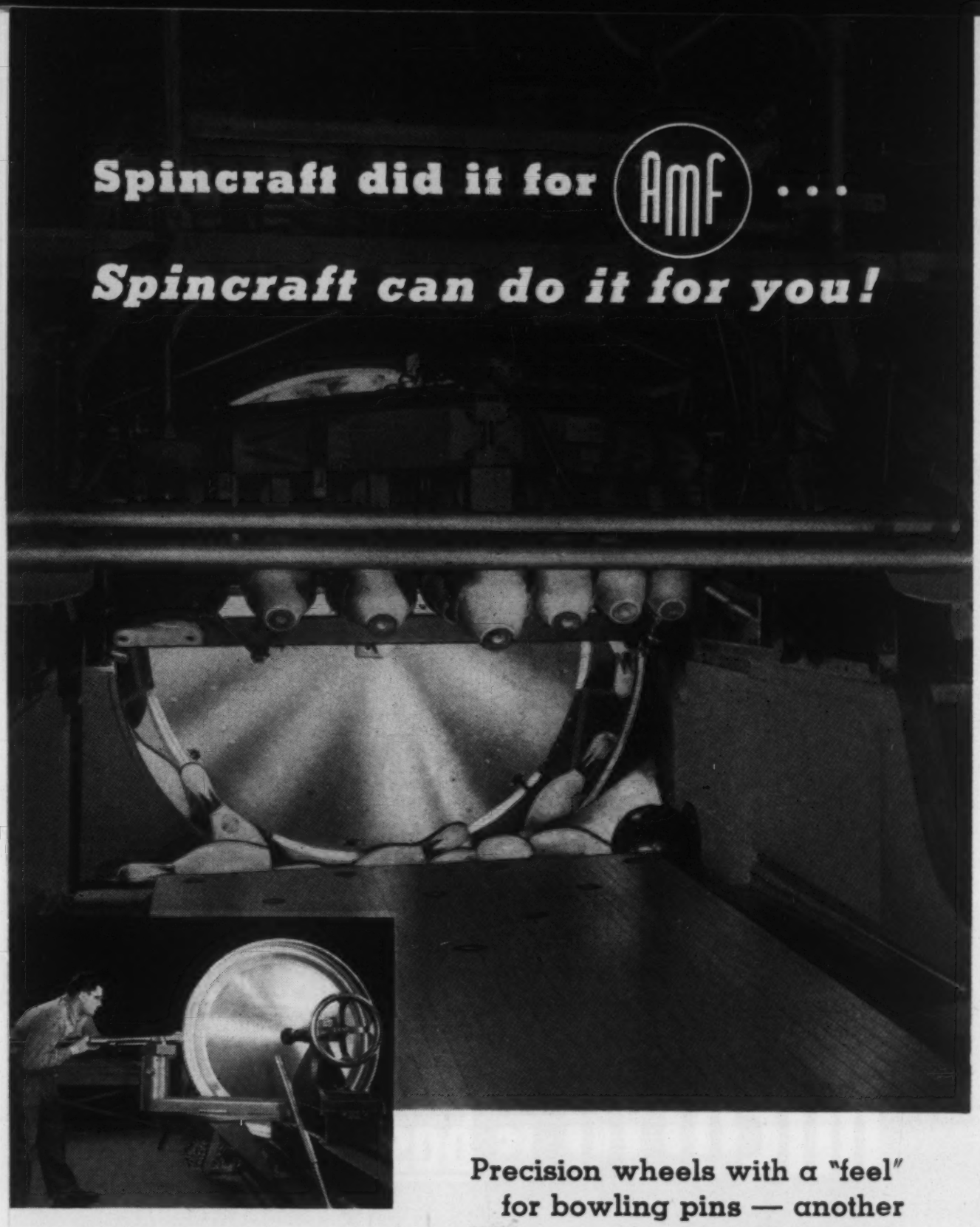

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Teflon Rod Extruded

Electrical grade Teflon rod is now being commercially extruded by *Tri-Point Mfg. & Developing Co., Inc.*, 401 Grand St., Brooklyn, N. Y. Rod is available in diameters from ¼ to ½ in., and quality certification of the material by an independent testing laboratory is available if desired.

Vinyl Plastisol Sponge

A new series of vinyl plastisols has been developed which when subjected to heat of 300-400 F for 3 to 30 min produces a uniform vinyl sponge. Temperature and time required for fusion depend on the size and mass of the object and cross-section of sponge. Called Sponge Vinyl Plastisols the materials have been developed by *Watson-Standard Co.*, 2 Galveston Ave., Pittsburgh 1 The plastisols contain chemical blowing agents and are shipped as pourable liquids. Expansion rate can be controlled by the compounder to provide expansions of 100 to 600% with densities ranging from 8 to 30 lb per cu ft.

The vinyl sponge is tough, flexible, non-shrinking, and resistant to oxidation, oils, greases, and most acids, alkalies and solvents. Sponge may also be made flame resistant and flexible at low temperatures. Cured sponge exhibits good sound-deadening properties as well as insulation against heat or cold. It is available in a wide range of colors.

The compounds may be spread coated, sprayed, molded, dipped or cast. When used in combination with vinyl plastisol skins parts can be produced in one operation, whereas several were previously required.

Applications for the material include rollers, arm rests, gaskets, toys, crash pads, sheeting, cushions, upholstery backing, rug backing, packing, insulation, boots, socks, and other items.

For more information, Circle No. 345

Contents Noted

A digest of papers, articles, reports and books of current interest to those in the materials field.

This Month:

- *Powder metallurgy developments*
- *Understanding protective coatings*
- *Progress in cermets*
- *Modified salt spray test*
- *Monel's high temperature strength*

Progress in Production and Use of Metal Powder Parts

The increasing interest in, and rapid growth of the powder metallurgy industry were reflected by the diversity of technical papers presented at the Eleventh Annual Meeting of the Metal Powder Association in Philadelphia last May. Subjects covered by the papers included finishing and plating of metal powder parts, machinability of sintered bronze, prealloyed steel powders, and a discussion of the economics of small volume production of metal powder parts (latter paper forms basis of article on p. 92 of this issue). Titanium powder metallurgy was discussed in two papers: one from the point of view of the powder producer, the other from the standpoint of the fabricator of titanium parts. The status of the iron powder industry in Europe was discussed in detail with respect both to the present and the future. Below are abstracts of these papers.

Plating metal powder parts

The steps which must be taken and the dangers which must be avoided in order to successfully plate a powder metal part are discussed in a paper by C. C. Cohn of Colonial Alloys Co. Mr. Cohn points out that while in many applications choice of metal powder instead of machined stock is evident, a closer look becomes necessary in applications where corrosion is a factor. Though impregnation and impregnation with plating have gone far toward solving the corrosion problem, care must be taken, as standard plating procedures used for plating other metal forms are not adequate for plating metal powder parts. This is due to the basic differences in internal and surface structure between metal powder parts and wrought or cast forms.

Early in the game it was recognized that it was necessary to fill internal voids before a satisfactory plate could be obtained. Though various methods were tried, impregnation of the sintered compact with a thermosetting resin has proved to be the most satisfactory. In many cases impregnation alone is satisfactory, since it increases corrosion resistance and prevents leaching back by keeping out fluids. Impregnation can be practically complete, or to within controlled depths leaving some voids for lubricants. After impregnating in vacuum, care must be taken to clean off excess resin in order to provide optimum adhesion between compact and plate. At the same time, too much resin should not be removed as this will expose additional porosity. Parts should be plated immediately after impregnation to preclude possibilities of plate failure due to reoxidation or contamination by atmospheres or other media.

Mr. Cohn mentions some of the plates recommended for various types of metal powder compacts. For protecting iron compacts, cadmium or nickel plates are recommended. Tin-zinc, tin-cadmium or tin-copper plates also give good protection from corrosion. On copper-base compacts, a pore-free, stress-free nickel plate is desirable. On aluminum-base, anodizing or zinc or cadmium plate. Chromate or phosphate treatments over zinc or cadmium plates have been known to increase corrosion resistance and, in some cases, to enhance the appearance of the plate.

Machinability of sintered bronze

In machining sintered bronze bearings, the Maytag Co. encountered problems in tool life and maintenance of dimensions on parts. W. A. Irvine, of that company, reports on the results of research carried out to solve the problems. First, a sintered solid solution structure was found to be essential for good machining properties. Tin, out of solution, in the form of the delta phase of the copper-tin system is a hard material and correspondingly difficult to machine. To obtain the solid solution condition, bearings are sintered at 1525-1545 F for 10-15 min, depending on their size.

Second, copper powder made by gaseous reduction of copper oxides was found to produce a bearing which has fine oxides scattered throughout the structure. Furnace atmospheres used would not reduce these oxides completely. Maytag is currently using electrolytically produced copper powder.

Third, the nature of the atmosphere used in sintering was found to be critical. A very dry gas is necessary to produce a desirable structure. The amount of moisture in the gas affects sintering, hence, machinability of the bearing. At present, Maytag uses a purified exothermic gas.

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For more information, turn to Reader Service Card, Circle No. 325

Contents Noted

have all but eliminated problems in machining sintered bronze bearing at the author's plant.

Prealloyed steel powders

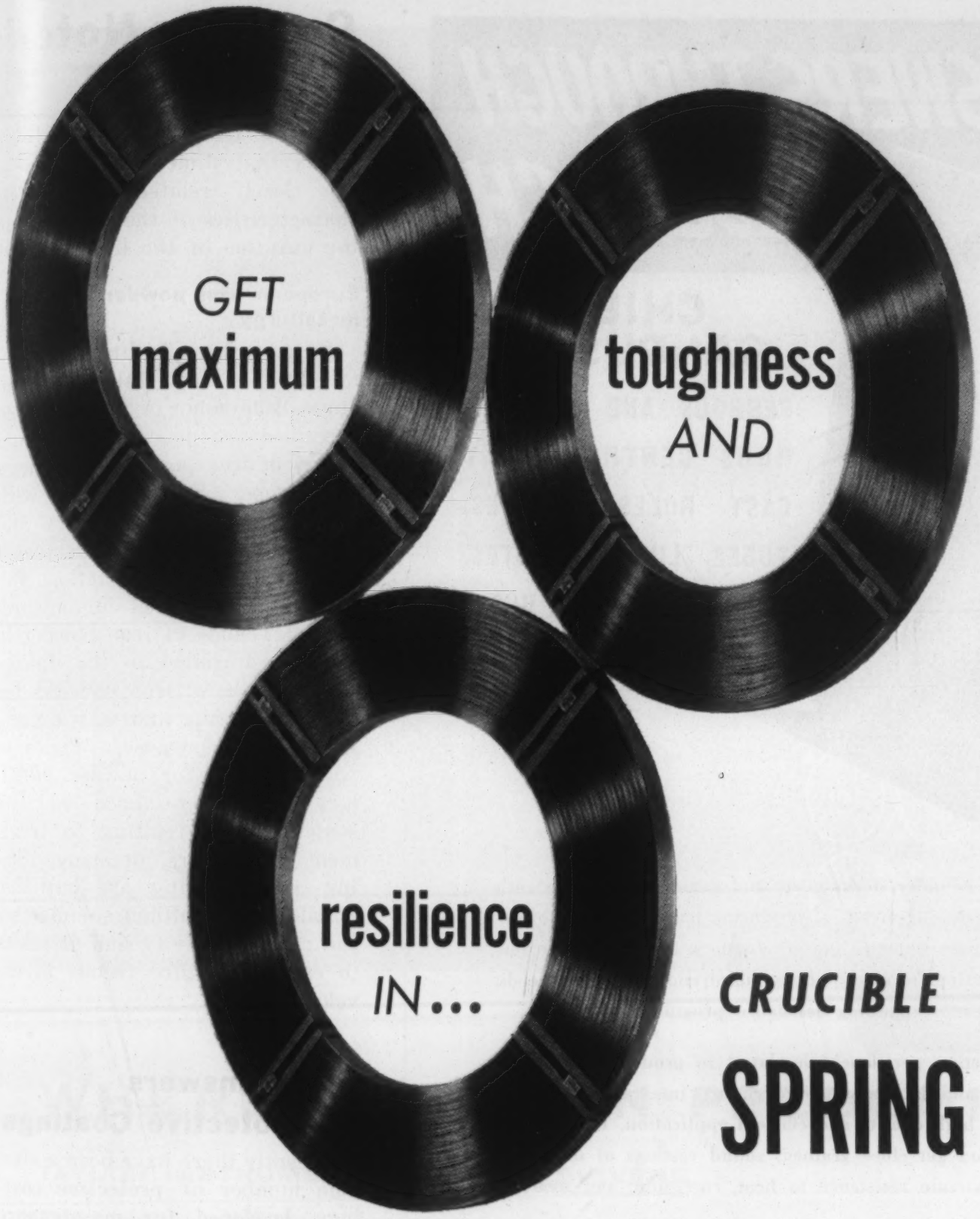
Each individual powder particle of prealloyed steel powders has the same composition, microstructure, hardenability and other characteristics as the corresponding alloy steels in massive state. In their paper, A. H. Grobe and G. A. Roberts of Vanadium-Alloys Steel Co., discuss methods of manufacture, properties and applications of prealloyed steel powders of both high-strength, low alloy and stainless types.

Earlier high-strength, low-alloy steel powders produced by rotating water jet disintegration of molten metal were essentially in a spherical shape, resulting in relatively low green strength. Powders now being produced are irregularly shaped, providing excellent green strength. The method used to obtain the desirable irregular shape is a proprietary technique of Vanadium-Alloys Steel Co.

Dimensional changes in iron-copper compacts

The addition of limited amounts of copper powder to iron powder seems to be one of the most popular ways of increasing the mechanical properties of iron parts. P. Ulf Gummeson of Hoeganaes Sponge Iron Corp., discusses in his paper various causes of dimensional changes in such compacts in an attempt to fill a few of the voids presently existing in knowledge of the technology of iron-copper compacts. Mr. Gummeson points out that for most iron powders the ultimate dimensions of the compact are larger when the powder is mixed with copper powder as compared to plain iron parts. The phenomenon is termed *copper growth*.

By detailing test results, Mr. Gummeson demonstrates the factors causing growth and shrinkage and suggests a theoretical approach. He gives special consideration to the case where the copper addition is below the solubility limit of copper in iron at



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THE ANSWERS THROUGH RESEARCH

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Contents Noted

sintering temperature. He also shows that dimensional changes are closely related to particle characteristics of the powder and the duration of the liquid phase.

European iron powder metallurgy

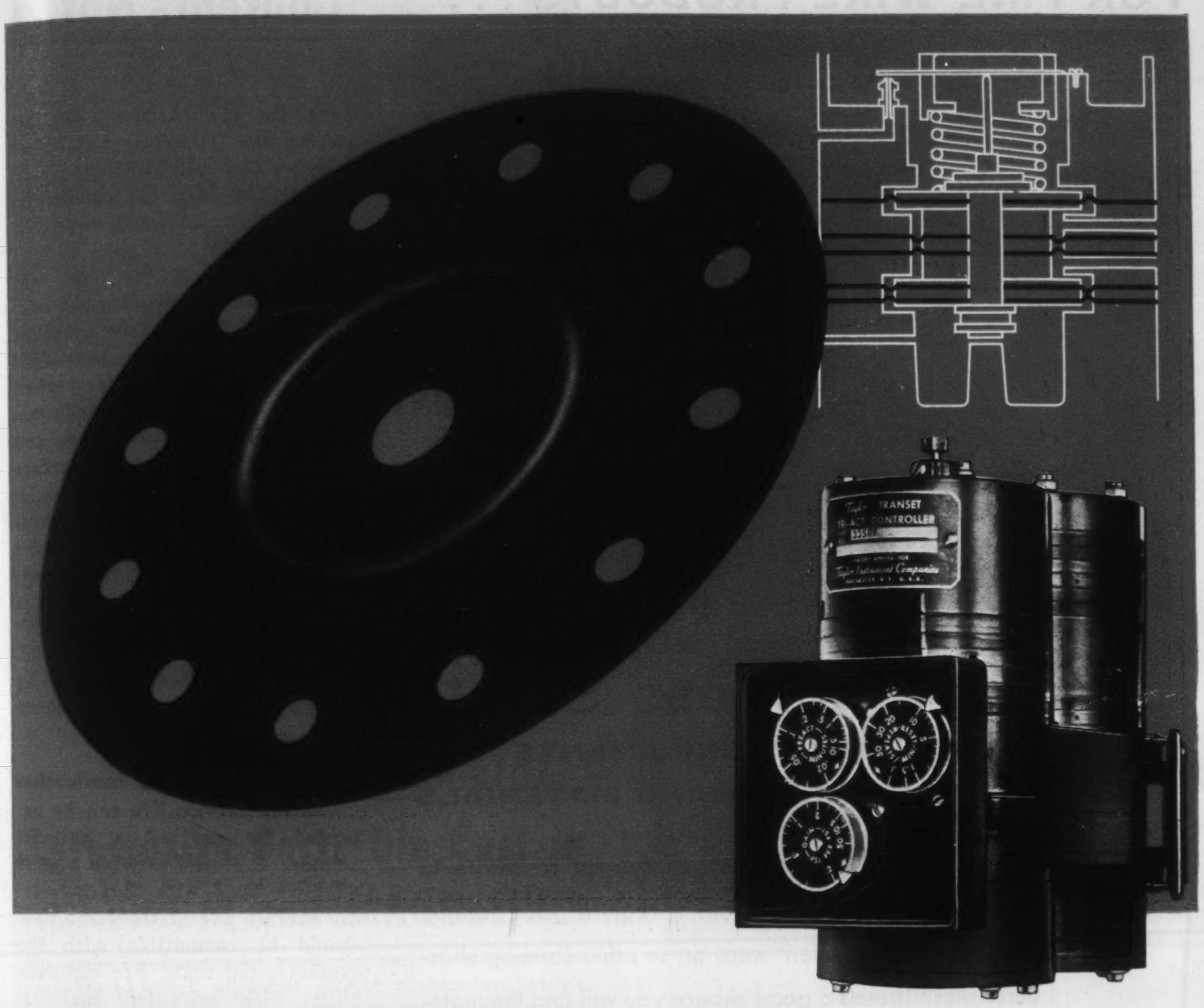
In a rather lengthy and detailed paper, S. I. Hulthén of Hoganas-Billesholms A/B of Sweden described the past, present and future of iron powder metallurgy in Europe. Fully backed with tables, diagrams, drawings and photographs, the paper includes a brief historical introduction, followed by statistics of current production volume of iron powder in Europe. Included in the discussion are uses of iron powders for welding, cutting and scarfing and for chemical purposes. Types of powders used for powder metallurgy are then discussed and some features relating to treatment of powders, pressing, tooling and sintering are outlined. Finally, Mr. Hulthén summarizes the present activity and attempts to estimate future trends in developments.

Some Answers on Protective Coatings

Recently there have been a sizeable number of protective coatings developed for maintenance painting. They include the vinyls, neoprenes, styrenes, phenolics, and furans. In a paper delivered before the Northeast regional conference of the National Association of Corrosion Engineers in May, J. H. Cogshall of Pennsylvania Salt Mfg. Co., answered some of the questions regarding techniques of application and the importance of some factors in applying an optimum protective coating.

What is the problem?

Mr. Cogshall points out that mixed results are obtained with organic coatings. There is no one reason why this occurs. Solvented organic coatings deposit a film that dries or sets, at least initially, by evaporation of solvents



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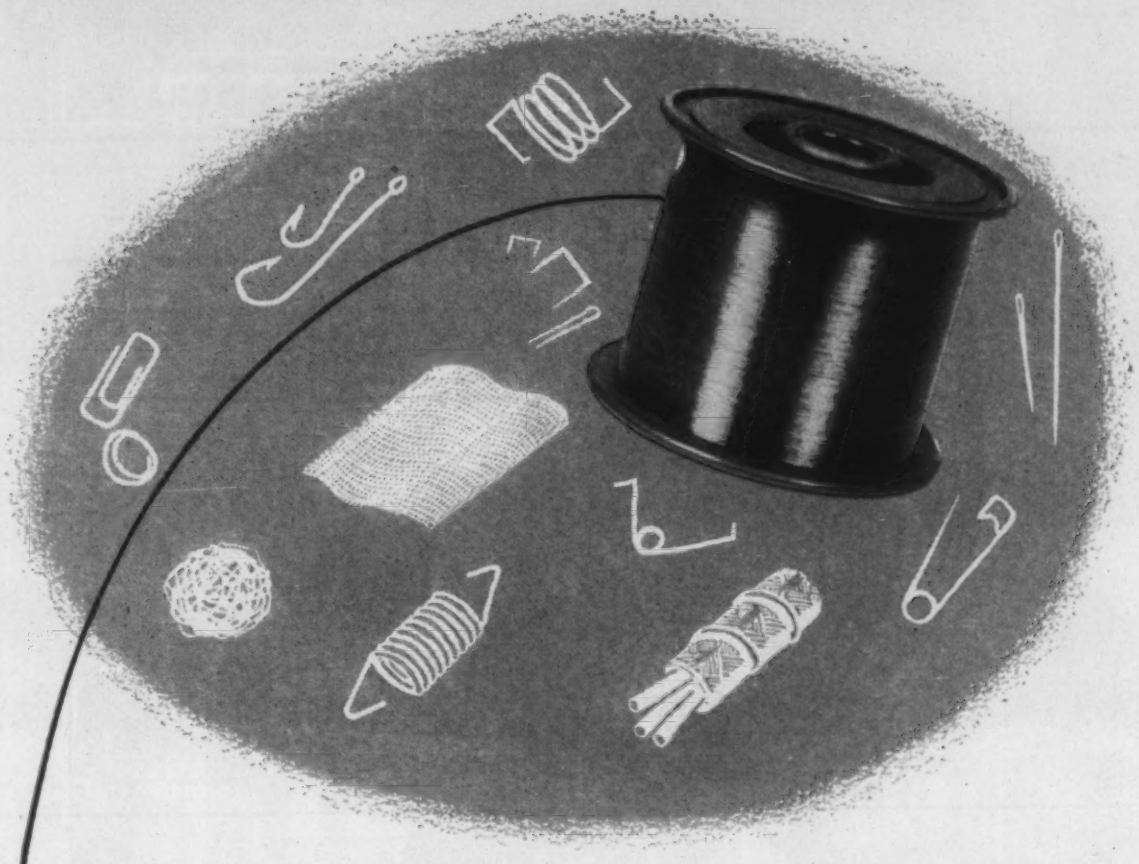

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Contents Noted

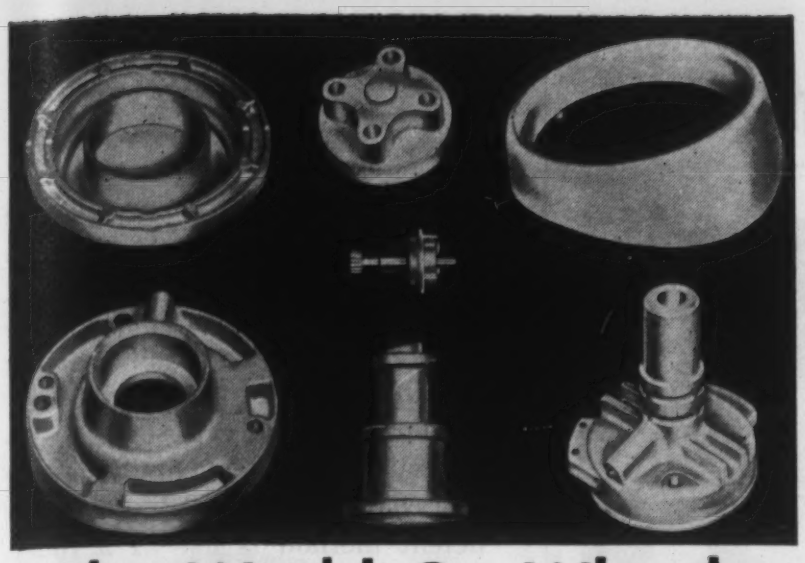
from the applied film. The resulting film frequently has better cohesive than adhesive properties. Therein lies both the virtue and fault of these coatings, says Mr. Cogshall.

Applications of the new synthetic coatings are generally only as good as the surface preparation. Solvented coatings have little tendency to wet a surface when applied. They do not naturally run down into pores, crevasses and other irregularities of a surface as an oil-based coating would. Hence degree of surface preparation has a greater effect on the resultant coating's performance. The ideal surface is one that is uniform, but has a marked tooth to promote a mechanical bond. Such a surface is produced by various blast cleaning or etching methods.

Primers and coating application

Coating service life can be extended by use of a suitable primer. It should provide a good adhesive bond with the underlying surface and at the same time should be compatible with the synthetic top coat. For compatibility with solvented coatings, the primer should also be solvented, bringing up again the difficulty solvented materials experience in wetting a surface, and the importance of surface preparation. Primers should be brushed on a surface rather than spray-applied to reduce bridging of pits and irregularities in the surface. Primers should also have sufficient corrosion resistance to prevent underfilm corrosion should the coating system be damaged or abraded. Some primers based on phenolic nitrile vehicles have shown promising results.

Though the principle of the 5-mil coating has been well established, most engineers think in terms of 3-coat applications to avoid excessive labor costs. Three-coat applications of most types of industrial coatings and paints average 3.5 mils in total coating thickness. However, there are several maintenance



The World On Wheels

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Carrier uses weather-seals by Tyer

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The company set up rigid specifications for a one-piece, completely weather-tight seal — and called in Tyer, specialists in rubber since 1856.

Engineers of the two firms developed an all-molded gasket with special suction properties. Water propelled from a fire hose at 70 pounds pressure will break through the glass before seeping under the seal. Corners of the gasket will withstand tension in excess of 100 pounds.

If *you* have a problem involving rubber, call in a Tyer Sales Engineer. Write Dept. 93 for our "Molded and Extruded" catalog.

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Rubber Company

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ANDOVER, MASSACHUSETTS

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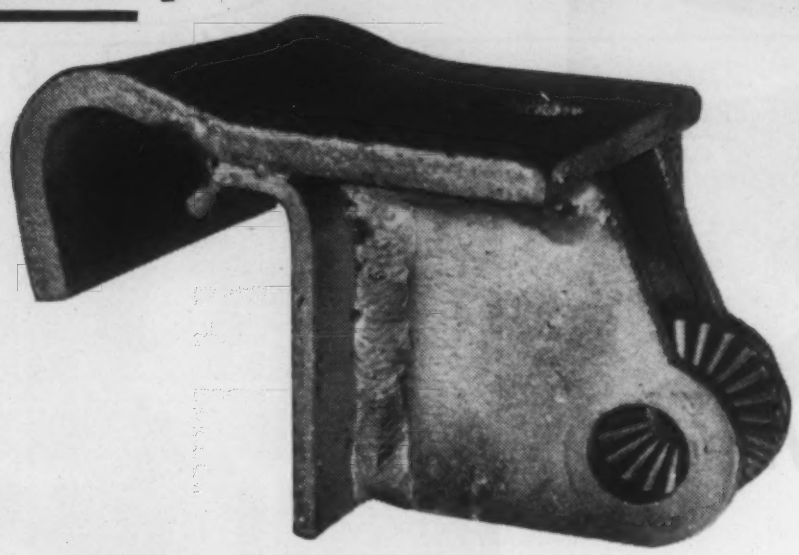

... with necessary cutting, punching, forming and welding!

...How about

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Stronger one piece malleable iron casting with better appearance

Better material selection exemplified by this trailer hitch is an everyday development in the malleable iron foundry industry.

The improved design, and therefore *appearance*, is quickly apparent. The big advantages are greater uniformity and dependability, and increased strength—*at lower cost* (in this case, 25% lower cost to the customer). The unit is completely stress relieved and benefits from a better distribution of metal than its fabricated predecessor. Improved damping properties and corrosion resistance are additional gains.

If you are not using malleable iron's remarkable properties, it will pay you to call a malleable foundry and go over your products with their engineers. Skilled in casting design, they show you how to save money and improve your products with Malleable Iron Castings.

Malleable
FOUNDERS' SOCIETY

1800 Union Commerce Building **Cleveland 14, Ohio**

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Contents Noted

type coatings that do provide the high build necessary to attain a 5-mil thickness in three coats. These include maintenance type neoprene coatings and various chlorinated resin type coatings.

Though there are several successful methods of applying the end coating, perhaps the most efficient method is use of a roller. The roller duplicates the action of the brush in reducing or eliminating the bridging action sometimes encountered with spray application. Roller-applied coatings are more uniform and thicker, and sags and runs can be picked up without lifting or rolling up the freshly applied coating.

Report on Cermets

Severe specifications by jet engine builders and the military have eliminated many cermets from the competition for materials to meet the higher and higher service temperatures encountered in gas turbine operation. The following three classes of materials seem at present to hold out the most promise of carrying working temperatures progressively up to 2100 F: nickel aluminides, titanium carbide with metal binder and borides of chromium-molybedenum. In the April issue of *Metal Progress*, F. W. Glaser of American Electro Metal Corp. gave a progress report on developments of these high temperature materials.

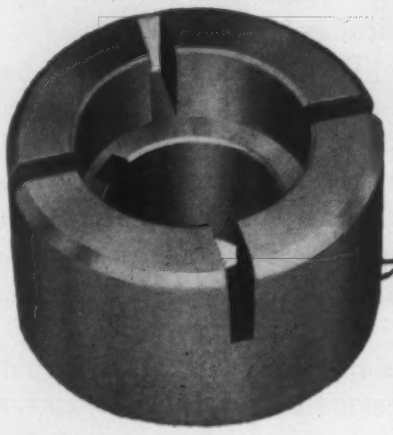
After summarizing early cermet development Mr. Glaser pointed out that though brittle at room temperature, in load-carrying ability certain cermets are far superior even to such an excellent alloy as X-40. Of cermets available today, those based on titanium carbide are undoubtedly the best developed. They have gone beyond the testing stage and into production of fairly complicated shapes. Turbine wheels made of the material are now installed in experimental engines

Due to the fact that very little was known about metal-boron

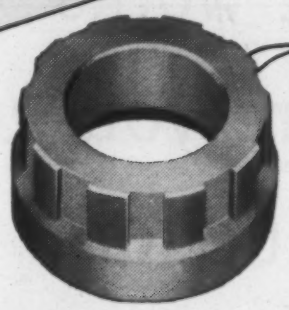
keyways splines and slots in these

GRAMIX® parts

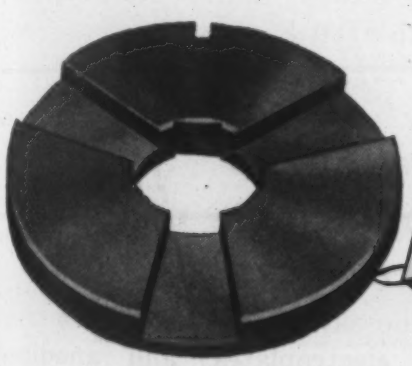
are practically FREE!



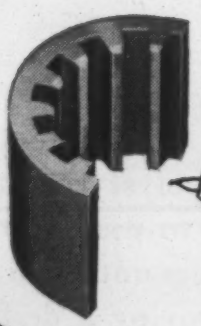
IRON COUPLING 20c
4 SLOTS, 1 KEYWAY 0c
20c



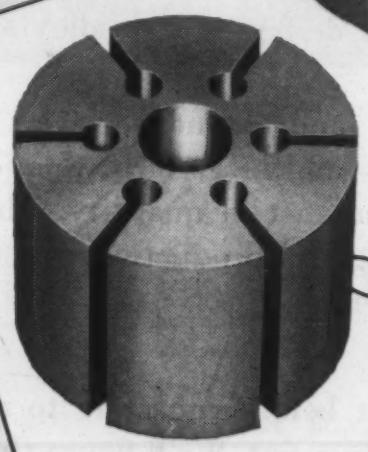
IRON ADJUSTER KNOB 6c
10 SPLINES 0c
6c



BRONZE ACCELERATOR PLATE 16c
3 GROOVES, 1 KEYWAY, 3 SPLINES 0c
16c



BRONZE ROLLER CAGE 6c
8 ROLLER SLOTS 0c
6c



IRON FUEL PUMP ROTOR 17c
6 SLOTS 0c
17c

BRONZE BEARING 4c
2 KEYWAYS 0c
4c

Because GRAMIX parts are pressed to shape rather than machined, all these keyways, slots and splines are in the die impression, so there is no machining cost. And the extra cost of dies is offset by the value of the metal saved. GRAMIX parts are made from metal powders compacted in presses and then sintered at high temperatures. Intricate shapes such as these can be held to tolerances as fine as .0005". They can be oil-impregnated to provide self-lubrication. GRAMIX parts cost less than machined parts yet often outlast them. Write today for full details.

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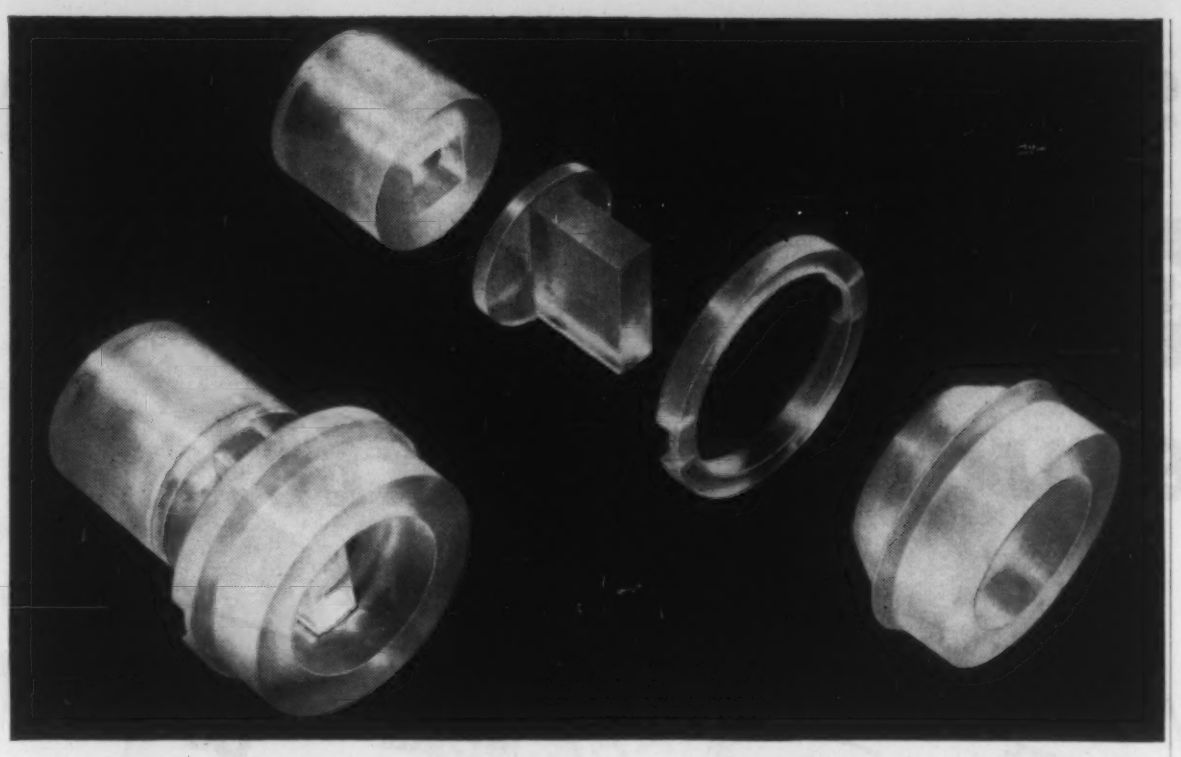

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Machine that part from polystyrene and let us investment-cast it in the metal you plan to use. Test it and, if some change is indicated, repeat the process until you have the final answer. This cut-and-try method of proving a design and an alloy saves you a lot of time and money.

Polystyrene machines readily and is inexpensive. Complex patterns can be made in sections and assembled, then cast as a unit just as they'd be investment-cast in quantity. Thus parts for testing are exactly like you'll get in production, but they cost far less than cutting them out of metal.

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pour yourself an assembly with

PRECISION METALSMITHS, Inc.

Investment Castings

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Contents Noted

systems at the outset of boride research, basic research on phase diagrams delayed the fabrication of parts and shapes for testing. It now appears, however, that the borides are catching up to the carbides, and will soon be commercially available for service at temperatures higher than those which the carbides are practical.

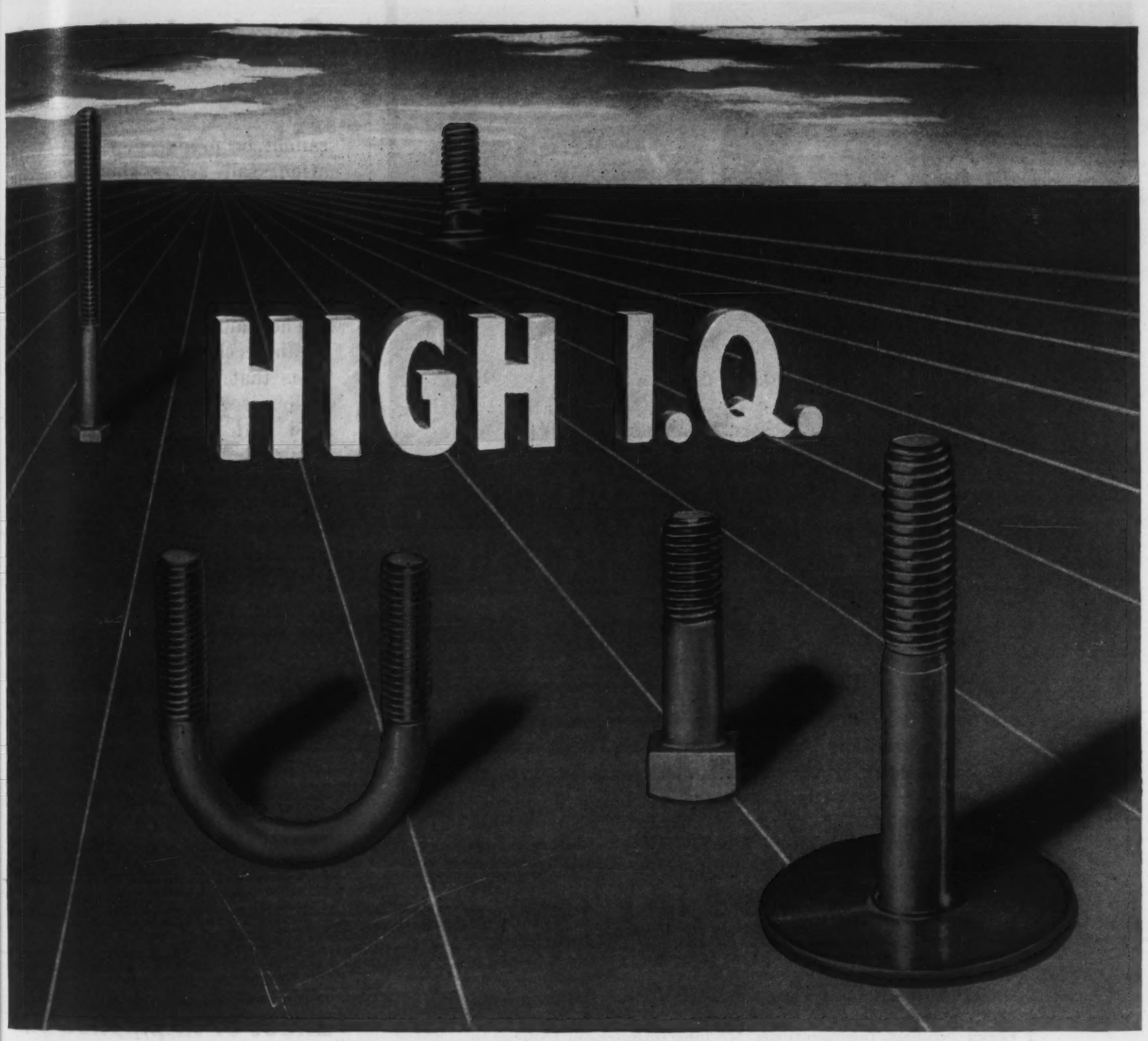
The nickel aluminides have received increasing interest due to their relatively good impact strength. However, serviceability reports on the materials cannot be expected before the end of this year.

The three materials — nickel aluminide, titanium-carbide-base cermets and the borides—have a promising future in the temperature scale above that point where superalloys fail: nickel aluminides at 1600, titanium-carbide-base cermets at 1800, and borides up to 2100 F.

Acetic Acid Modification of Salt Spray Test

The salt spray method of testing electroplates, and anodized and phosphated aluminum has taken 40 years to develop. Due to the difficulties encountered in the use of the 20% salt solution, a 5% modification has been recommended. However, due to the unsuitability of salt spray for testing plated parts, the American Society for Testing Materials set up a committee to study a proposed modification entailing the addition of 1% glacial acetic acid to the 20% or the 5% solution. In a report published in the *ASTM Bulletin* in January, W. D. McMasters of General Motors, details the results of the committee's study.

In considering salt spray testing, it should be pointed out that the salt spray is a means of comparing the quality of paint systems, rust-proofing systems and plating systems as well as film thickness. Since plated standards



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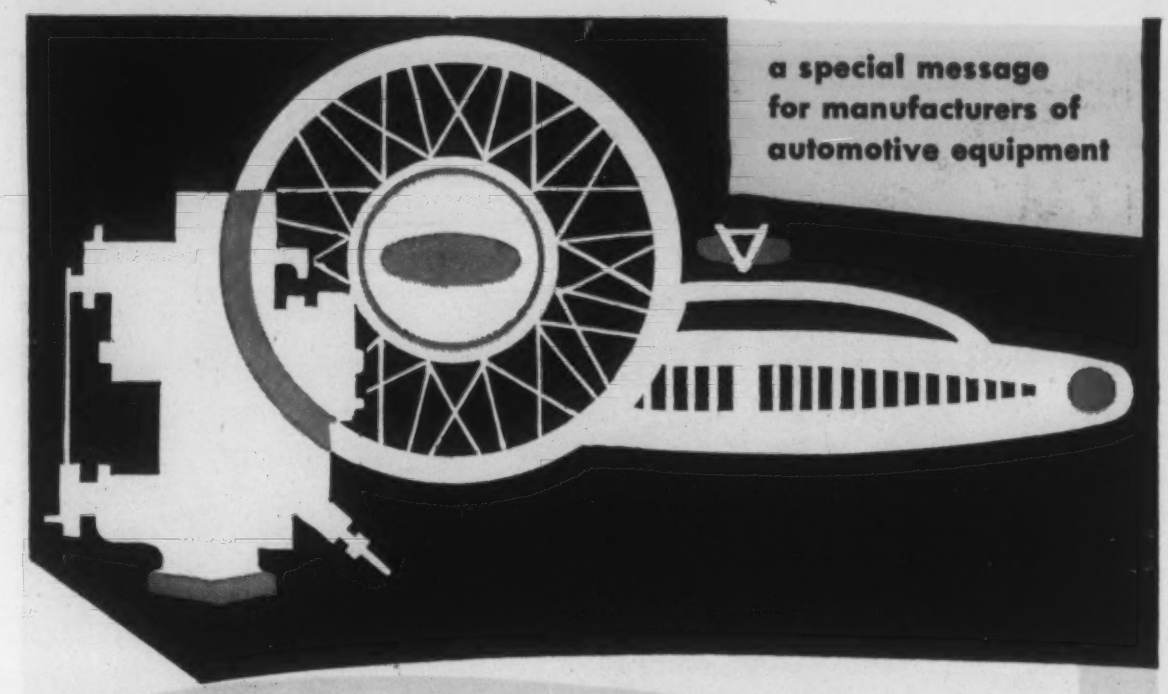

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Contents Noted

cannot be produced without variation, salt spray should not be used to differentiate between plates that produce one spot per sq in. and two spots per sq in., even though the difference be 100%.

The salt spray is intended to be an accelerated test. Data indicates that the acetic acid modification is not only more accelerated but is more universally applicable, according to the author. He emphasizes, however, that it would be unreasonable to expect test developments to match service developments perfectly in appearance. Suffice it to say that the item which fails first in test, will fail first in service.

The temperature at which the test is run determines speed with which a point of failure is reached. The best temperature for universal testing seems to be 95 F, though a temperature of 120 F may be used if necessary. The acetic acid test is offered as a test for all plated parts, anodized and phosphated aluminum and its alloys, and such other items as may be desired.

Effect of Impurities on High Temperature Strength of Monel

Though the effect of elevated temperatures on 70 nickel, 30% copper alloys (Monel) has been described in several publications, little information is available on the effect of impurities on these properties. Under the auspices of the National Bureau of Standards an investigation was carried out during which short-time tensile tests were made at temperatures ranging from 75 to 1700F on two lots of 70 nickel, 30% copper alloys of the same initial grain size and structure. However, one alloy was of relatively high purity, while the other was a commercial grade containing appreciable amounts of manganese, iron and cobalt. In a paper published in the Journal of Research of the National Bureau

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NYLAFLOW . . . the new POLYPENCO® nylon tubing . . . now promises a new kind of performance in pressure lines for lubricants, air, fuel and oil, coolants, process streams, and hydraulic fluids. NYLAFLOW tubing is flexible, resilient and tough. It also resists abrasion and corrosion. Yet, it is economical to use from beginning to end.

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Available with a tested bursting strength of 1,000 psi or 2,500 psi, NYLAFLOW tubing costs less in some small sizes than copper tubing. It also costs substantially less than flexible rubber hose of comparable bursting strength.

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Flexible NYLAFLOW tubing does away with pre-bending, intermediate fittings, and the need for flexible hose attachments. It can be run in continuous lengths and connected simply by using a standard metal compression or flare fitting at each end. What's more, it's available in colors for color coding.

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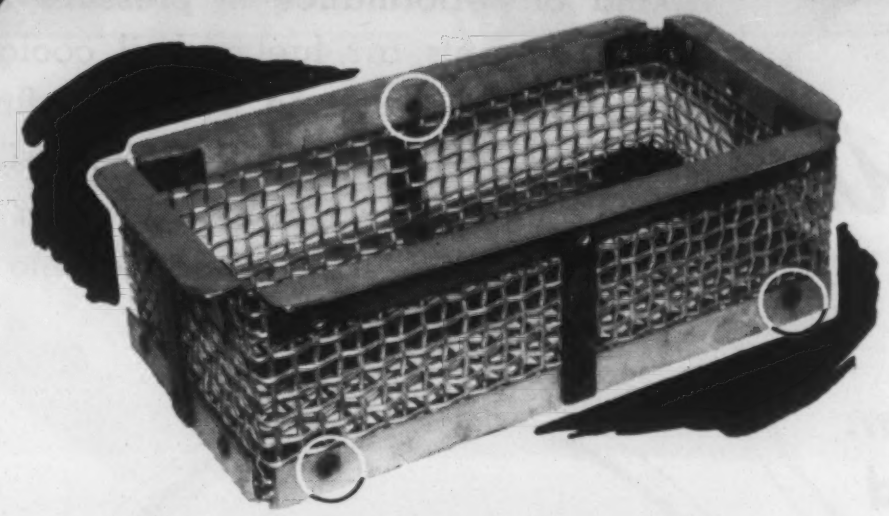

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Since we introduced Interlock with its exclusive "tubular rivet" construction, daily use in annealing, carburizing, carbonitriding has proven that Interlock all but eliminates maintenance and assures life far in excess of ordinary heat-treating fixtures. Heat treating stresses and strains are minimized because Interlock construction allows free movement of all joints and specific allowances for thermal expansion. Corrosion-free service is guaranteed by fabrication from metal or alloy to match process conditions. Here are a few reports we've received from leading manufacturers:

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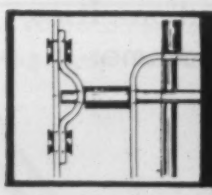
"Using only 11 Interlock baskets, we saved $19,360 in 18 months, even though the Interlock unit-cost was almost twice that of old equipment."
—Electrical equipment manufacturer

✓ PROOF

"Our first 15 Interlock units look like new after constant use in carburizing and oil quenching . . . please fabricate 30 more units."
—Automobile manufacturer

✓ PROOF

"We've had no down-time since we started using Interlock."
—Machinery manufacturer



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Contents Noted

of Standards in January, W. D. Jenkins, T. G. Digges and C. R. Johnson detailed the results of this investigation.

Results summarized

Serrated stress-strain curves, more noticeable for the high-purity than for the commercial alloy, were obtained on specimens tested at temperatures ranging from 300-900 F. Discontinuous flow also occurred in specimens of both alloys tested at temperatures above 900 F. Serrations were interpreted as being associated with strain-aging and other atomic rearrangements, and discontinuous flow as being associated with recrystallization and grain growth. Strain-aging was also evident in the strength-temperature relationships of both alloys. This was especially prominent in curves for tensile and fracture strengths.

According to the authors, variations in composition of the two alloys had a marked effect on their yield, tensile and fracture strength and on reduction of area at temperatures below 1100 F. Above 1200 F, strength properties were quite similar. Values obtained for ductility were influenced by the composition. At 1200 F, ductilities of both alloys were nearly the same.

Rates of work-hardening varied with test temperature, amount of strain and alloy composition. Results of hardness tests made at room temperature on specimens of both alloys fractured in tension at different temperatures indicated 1) predominance of strain-aging and work-hardening at the low range in temperature, 2) a balance of work-hardening and recovery in the intermediate range, and 3) predominance of recrystallization and recovery at the higher temperatures used in tensile testing.

At temperatures below 900 F specimens of both alloys contracted locally before fracturing in a ductile manner with a rim. Above 900 F, specimens of both alloys deformed more uniformly before fracturing in a relatively

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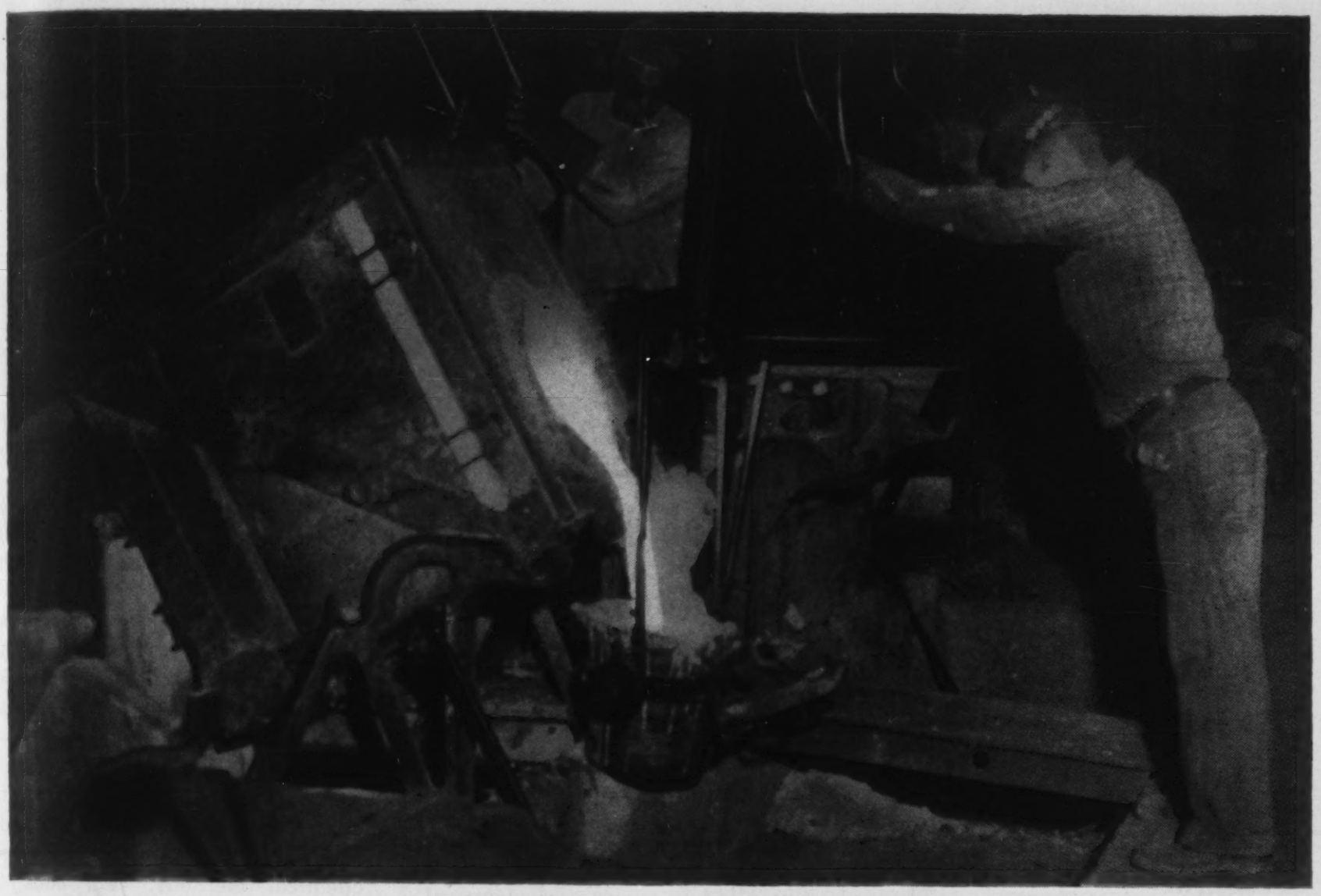
Another Norton Rx *on the job!*



One of the 1200-pound Ajax induction furnaces used by The Duriron Company, Inc. of Dayton, Ohio. Melts are chiefly stainless steel alloys, tapped at 3200°F or higher. MAGNORITE cement, the Norton Rx for lining and patching these furnaces, has resulted in substantial savings — not only in the amount and cost of cement, but in time and labor.

The Duriron Company, Inc. doubles heats-per-lining, cuts melting costs, maintains stainless steel quality with MAGNORITE cement*

If re-lining is too frequent a job in your induction furnace operations — if you're using up too much time, cement and money to get maximum heats — we suggest you consider MAGNORITE cement.

Take the experience of The Duriron Company, leading manufacturers of chemical process equipment made of stainless steel and other metals. Before trying MAGNORITE cement, their best previous lining material was giving an average of 68.2 heats per lining. Thorough test runs of MAGNORITE at the Duriron foundry show this Norton refractory material is averaging 140.5 heats per lining. And it is not only lasting twice as long as its best performing competitor, it is more refractory, it has 50% less slag volume on heats, and its freedom from shrinkage eliminates cracking. Another instance of how Norton refractories and refractory materials are *engineered and prescribed* to provide time-and-money-saving Rx's.

Give MAGNORITE cement a test run

in one of your own furnaces. Note how it withstands temperatures up to 3250°F — how its high-rammed density resists metal penetration, erosion and chemical attack — how its slight expansion when sintered eliminates shrinkage cracks in the crucible lining.

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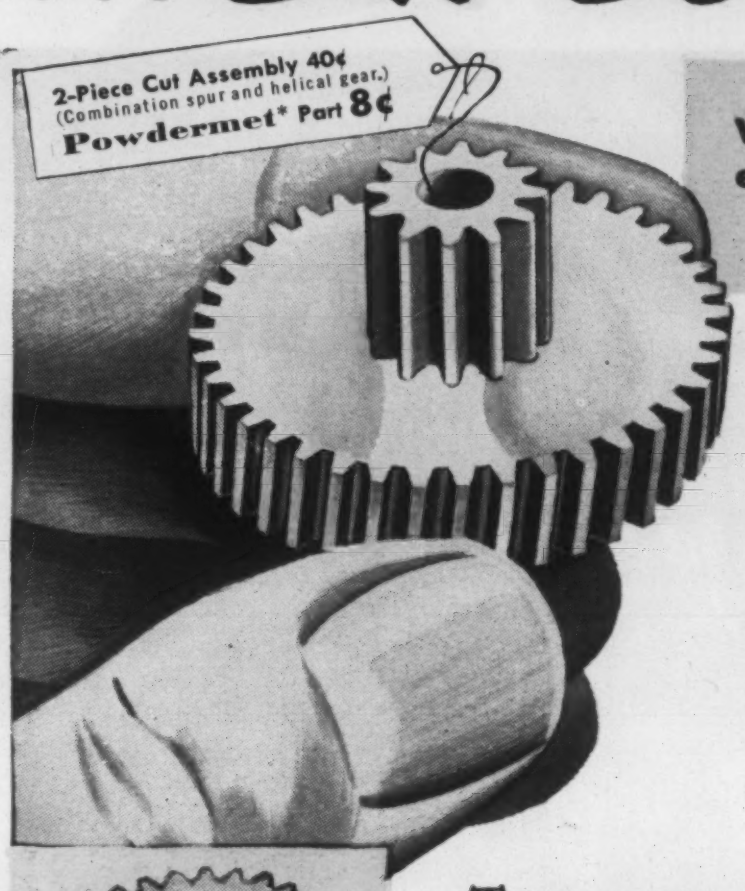

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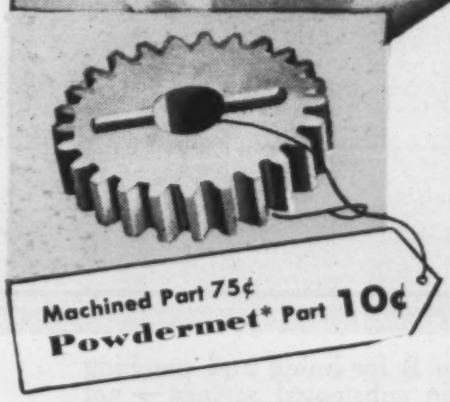

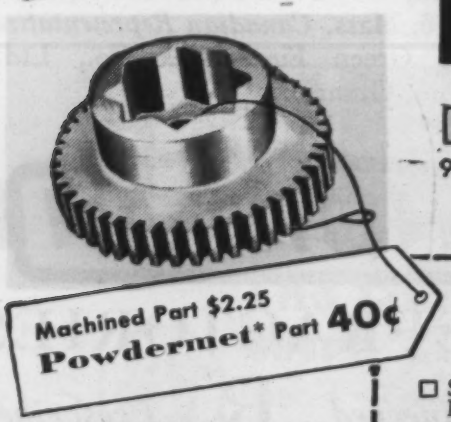

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Low-cost PM parts are die-pressed to close tolerances, have excellent wearability, and a wide range of alloys are available—many exceeding the tensile strengths of mild steel. Through controlled porosity and electrical permeability, many special properties are achieved . . . such as oil-impregnation for life-time self-lubrication. That's why Powdermet* parts are often the *best parts possible* for gears, bearings, filters, etc.

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Company.....
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Contents Noted

brittle manner without a pronounced rim. Necking and fracture characteristics were also affected by the composition of the alloys. Final structures and microcracks produced in specimens fractured at different temperatures varied with test temperature, amount of plastic deformation and composition of alloys.

Books . . .

Vapor Plating. *C. F. Powell, I. E. Campbell, and B. W. Gonser. John Wiley & Sons, New York 16, N. Y. 1955. Cloth 6 by 9 in. 158 pp. Price $5.50.*

This book, the latest in a series of publications sponsored by the Electrochemical Society, is the only book to treat the formation of coatings by vapor-deposition as a major subject. The aim is to publicize the versatility of vapor-plating processes to stimulate their use in technology.

Although the term *vapor plating* has been used frequently to describe both physical methods such as vacuum-metallizing and chemical methods, this book is restricted to the discussion of chemical processes. Included are discussions of the methods of applying the plating techniques, properties of coatings and suggested applications. Topics covered include metals, carbides, nitrides, boron and borides, silicon and silicides and oxides.

Metal Industry Handbook and Directory 1955. *Louis Cassier Co., Ltd., London S. E. 1, England. 1955. Cloth 6 by 9 in. 472 pp. Price $2.10 net.*

This is the 44th edition of this standard reference to nonferrous materials and practices. Up-to-date information is given on the properties of both well-known and less common metals, and an extensive section is devoted to summaries of British Standard, Aircraft Material, D. T. D. and Admiralty specifications. A section on the metal finishing processes is included. Two new features appear in this edition—a list of trade

5 MONTHS In five months, hard-fired brick in scroll of sinter machine's cyclone dust collector has been cut back to shell in several spots by abrasive sinter dust.

7 YEARS CARBOFRAX silicon carbide brick lining in the cone still offers considerably more useful life after *seven years'* service.

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Silicon carbide, the principal component of CARBOFRAX linings, is one of the hardest materials known to man. It is so hard that even high-velocity gases laden with sharp particles fail to leave their mark.

To keep initial costs down, CARBOFRAX brick and shapes are used only in the areas where abrasion is most severe. They last longer and help the surrounding brickwork to last longer, too. So even though CARBOFRAX refractories are more expensive than some other lining materials, they are proving more practical . . . *and more economical to use.*

An inexpensive way to see for yourself what a silicon carbide lining can do is to install a few courses of CARBOFRAX brick at the area of worst erosion and check on their condition as time passes. You'll soon want to investigate further! For detailed information write Refractories Division, The Carborundum Company, Perth Amboy, N. J., Dept. R75.

Nothing resists abrasion like an abrasive!

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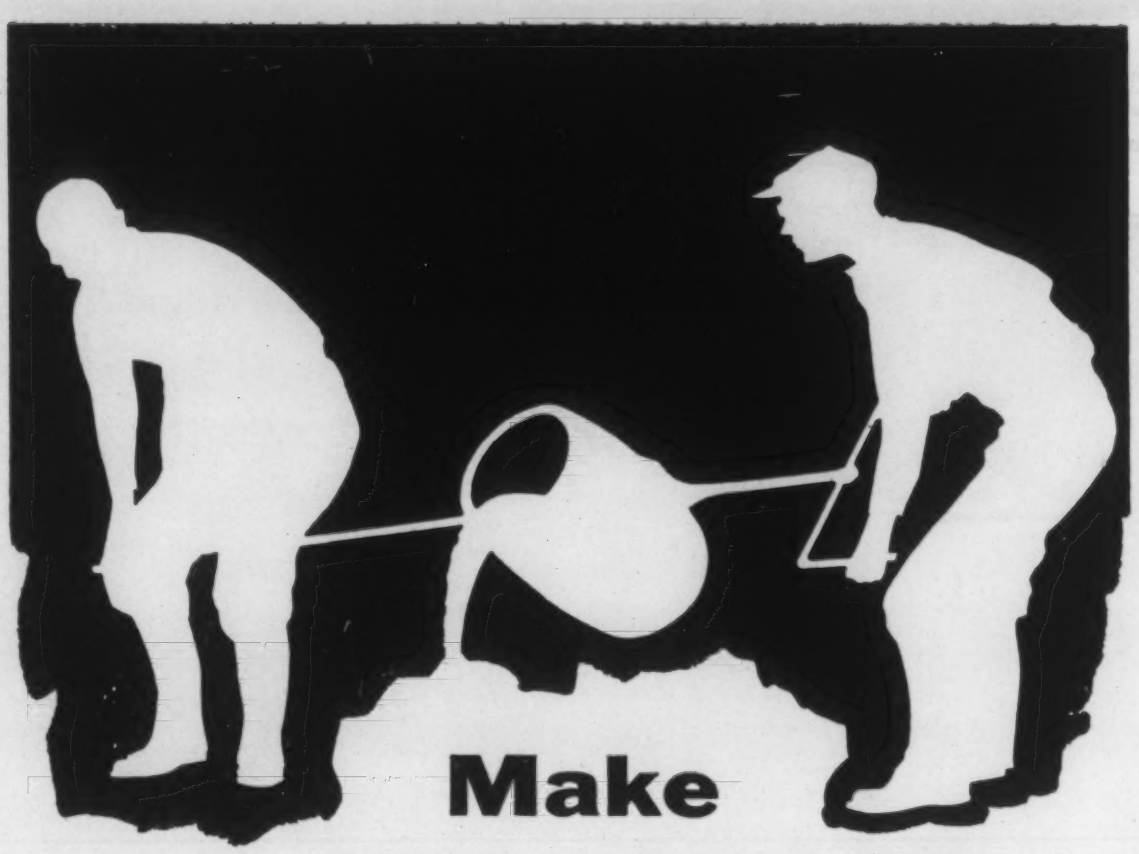

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Federated first in the non ferrous field — FMD

For more information, turn to Reader Service Card, Circle No. 326

Contents Noted

Books . . .

names and standards for the classification of nonferrous scrap.

Although the book is written especially for British use, it will prove valuable to the American metallurgist and materials engineer as a ready reference source of much valuable information on nonferrous metallurgy.

Materials for Nuclear Power Reactors. *Henry H. Hausner and Stanley B. Roboff. Reinhold Publishing Corp., New York 22, N. Y. Cloth 5 by 7 in. 224 pp. Price $3.50.*

The rate of progress in the industrial development of nuclear reactors depends on the dissemination of information which has already been declassified by the Atomic Energy Commission. This book, latest in the Pilot Book series, has been prepared to cover the critically important portion of the field dealing with the materials involved.

The basic types of materials used in reactors, their functions and the problems associated with their use are covered as fully as national security permits. The book contains twelve chapters, covering concepts, parts and types of reactors, special materials problems, nuclear fuels, moderators and reflectors, coolants, control elements and materials for reactor shielding. An appendix lists the thermal neutrol cross-sections for the elements and some isotopes and contains a glossary of nucleonic terms.

This book will serve as a ready guide for the scientist and materials engineer, but it is written in a manner which will make it valuable for those interested in the atomic energy field who are not technically trained.

Specifications and Tests for Electrodeposited Metallic Coatings. *American Society for Testing Materials, Philadelphia 3, Pa. 1955. Heavy paper 6 by 9 in. Price $1.85.*

This publication brings together in convenient form, all of the ASTM specifications and methods

they grip tight...seal tight
—they're made of

CRUCIBLE
stainless steel cold heading wire

These *Tuff-Tite** fasteners, made by Townsend Company, New Brighton, Pa., have a neoprene washer preassembled into the head. They stop leaks . . . hold tight even where there's severe vibration . . . seal out moisture effectively.

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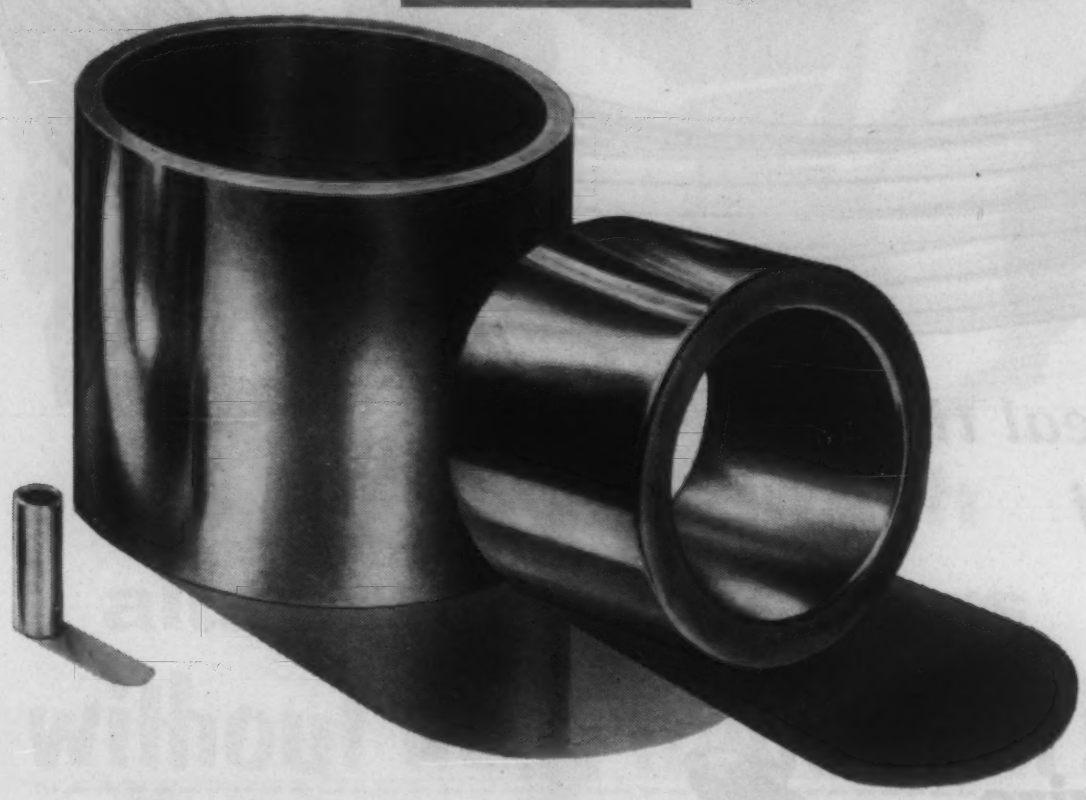

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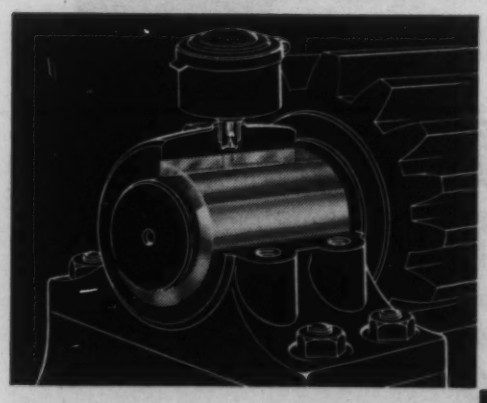

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Contents Noted

Books . . .

of test which pertain to electrodeposited metallic coatings. It contains 8 specifications, 2 methods of testing and 7 recommended practices.

Proceedings of the Shop Practice Forum, Volume 16. *Porcelain Enamel Institute, Wash. 6, D.C. 1955. Paper 6 by 9 in. 193 pp. Price $5.00.*

This publication covers the proceedings of the Forum held at the University of Illinois in Sept. 1954. It includes thirteen reports on latest industry developments, a series of reports on processing methods in the enameling industry, six papers on the use of color and a series covering practical tests for enamelers.

Machining Aluminum. *The Aluminium Development Assoc., London W1, England. 1955. Paper 6 by 9 in. 56 pp. Price 25¢.*

The book opens with an outline of the machining characteristics of aluminum followed by a classification of the alloys based on experience. The major portion of the work covers operations such as turning, boring, parting, etc., with recommendations on speeds, feeds and tool angles. A brief discussion of the common causes of distortion during machining and precautions which can be taken to avoid the problem in aluminum. An appendix gives British specifications for aluminum alloys.

Reports . . .

High Temperature Alloys Cooperative Investigation of Relationship Between Static and Fatigue Properties of Wrought N-155 Alloy at Elevated Temperatures. *NACA Subcommittee on Heat-Resisting Materials, Apr. 1955. NACA TN 3216, 92 pp, diagrams, photos, 13 tables. Available from National Advisory Committee for Aeronautics, 1512 H St., N.W., Wash. 25, D.C.*

Extensive data are given relating properties of N-155 alloy under static, combined static and

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that gives complete protection . . .

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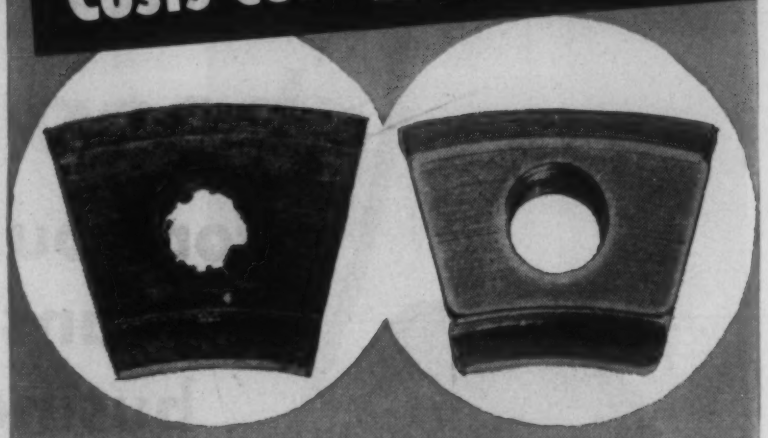

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SPECIALISTS IN STAINLESS STEEL TUBING

For more information, turn to Reader Service Card, Circle No. 422

Contents Noted

Reports . . .

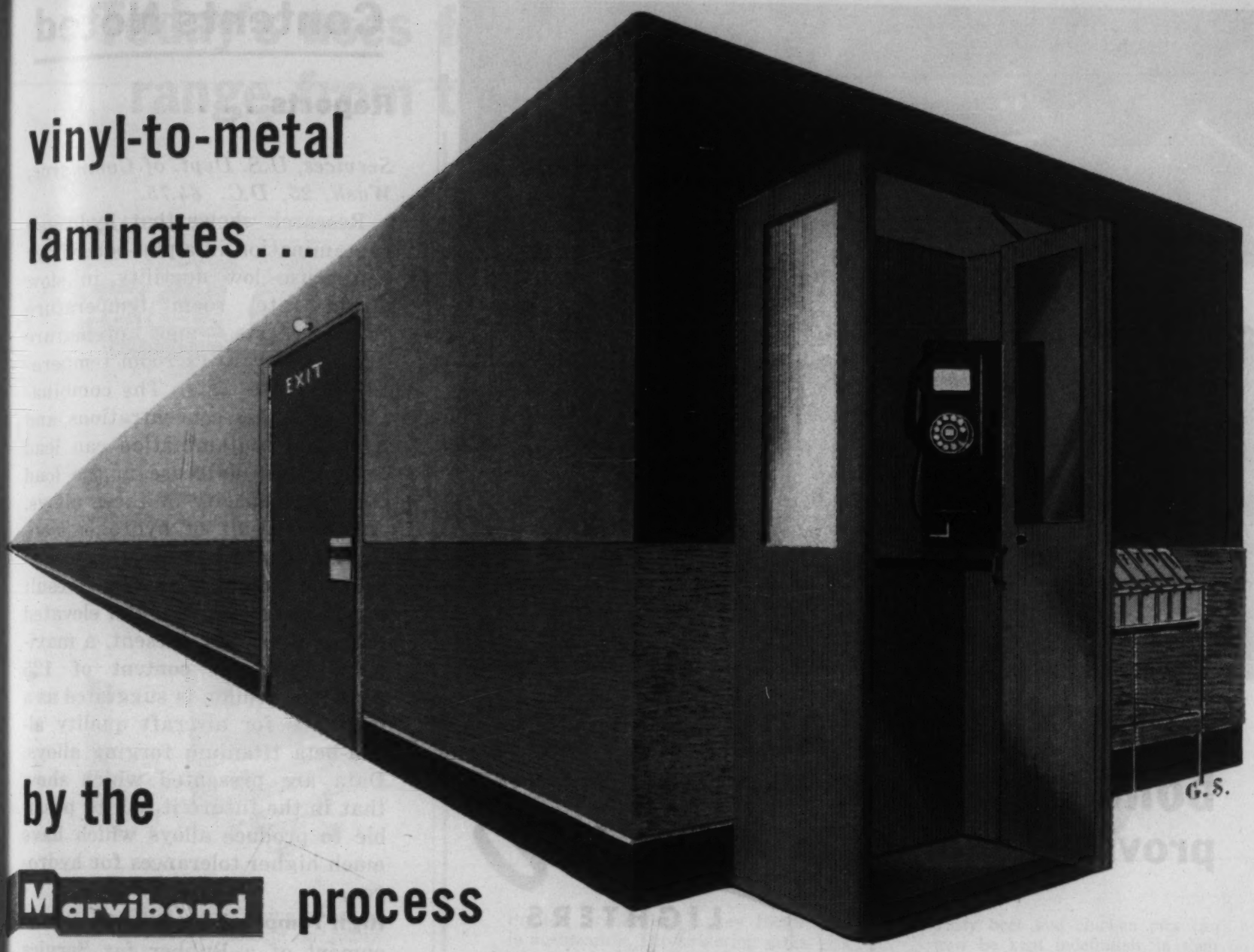
dynamic, and completely reversed dynamic stress conditions. Time periods for fracture ranged from 50 to 500 hours at room temperature, 1000, 1200, 1350, and 1500 F. The work was on a cooperative basis to help clarify the principles governing load-carrying ability of heat-resistant alloys at temperatures and conditions where both creep and fatigue can occur simultaneously. In view of the uncertainty in interpreting results of various types of fatigue tests, duplicate data were obtained from as many types of fatigue testing machines as could be arranged.

Hydrogen in Titanium The Effect of Hydrogen on the Mechanical Properties of Titanium and Titanium Alloys. *Battelle Memorial Institute for Watertown Arsenal, U.S. Army Ordnance Corp, July 31, 1953. PB 111568 83 pp, illustrations, charts, graphs. Available from Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D.C. $2.25.*

Results are given on the effects of hydrogen on high purity and commercial purity titanium, alpha titanium alloys of the Ti-N and Ti-Al types, two commercial alpha-beta alloys (RC-130A and RC-130B), and high purity titanium-manganese alloys. This work indicates that hydrogen does not have any beneficial effects and is an impurity that must be kept under close control to obtain the maximum advantage from titanium alloys. The mechanism of hydrogen embrittlement of titanium and alpha alloys is shown to be different from that of alpha-beta alloys.

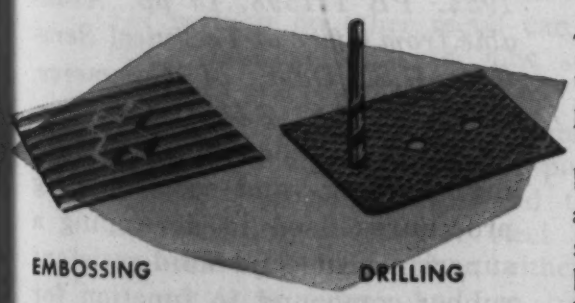
Hydrogen Contamination in Titanium and Titanium Alloys, Part 1, Hydrogen Embrittlement in Alpha-Beta Titanium Alloys. *Wright Air Development Center, Jan. 1955. PB 111620, 185 pp. Report of WADC technical meeting Oct. 29, 1954 including papers, discussions, and illustrations. Available from Office of Technical*

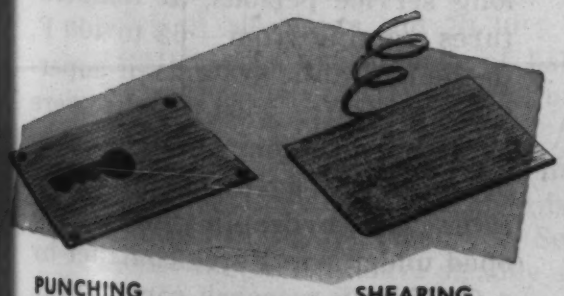
vinyl-to-metal laminates...

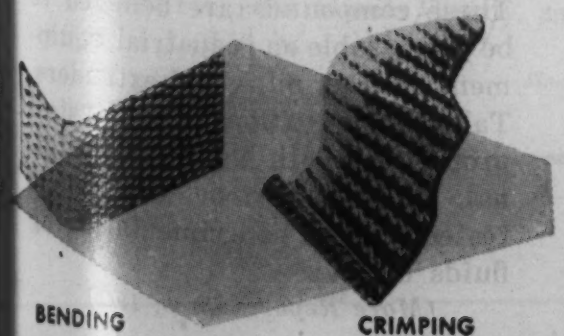


by the Marvibond process

for beauty and practicality in a building material







The Clad-Rex Steel Co.† produces vinyl-to-metal laminates by the Marvibond process.

Scuff-proof and rust-proof vinyls are being permanently united with steel and aluminum, by Clad-Rex, at a rate of 4,000 sq. ft. an hour. And Naugatuck's Marvibond process makes this possible... the bonding of specially formulated vinyl film or sheet to most metals on a continuous production basis.

The Marvibond* process permanently weds the vinyl to the metal *before the product is formed*...eliminating expensive finishing operations. Marvibonded vinyl-metal laminates can't be separated by bending, crimping, drilling, embossing, punching, or drawing... can be formed with standard metal working tools.

Practically any surface effect can be achieved! Smooth or matte finishes, leather-like grains, marble patterns, prints, weaves, and sculptured appearances are not only possible but *economical.* And Marvibonded vinyls will not chip, crack or craze...are far superior to paints, lacquers, varnishes, phenolic and alkyd finishes.

Why not consider the advantages that Marvibonded laminates can add to your products? This exceptional material has a great future in wall paneling, vending and business machines, office furniture and automobile interiors... in fact, *wherever* sheet metal is used.

For samples and technical information, write to us on your company letterhead, TODAY.

†Denver, Colorado

*Patent applied for

Naugatuck Chemical

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bonds metal-to-metal . . .
provides sealant in ZIPPO LIGHTERS

Conclusive tests have proven that HYSOL Adhesives can meet the most exacting industrial bonding requirements of metal, glass, laminates, ceramics, wood and synthetics. Years of experience in industrial research have developed HYSOL adhesives with outstanding resistance to temperature variations, chemical or electrical attack, with no cracking, chipping or loss of any of its other properties.

HYSOL adhesives more than satisfied ZIPPO requirements for a material with a two-fold purpose; to bond metal-to-metal and to act as a sealant. If you have a special problem in industrial adhesives, Houghton Laboratories is ready to serve you. The ZIPPO and many other varied applications of HYSOL industrial adhesives now in use provide excellent experience in helping solve your problem.

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For more information, turn to Reader Service Card, Circle No. 375

Contents Noted

Reports . . .

Services, U.S. Dept. of Commerce, Wash. 25, D.C. $4.75.

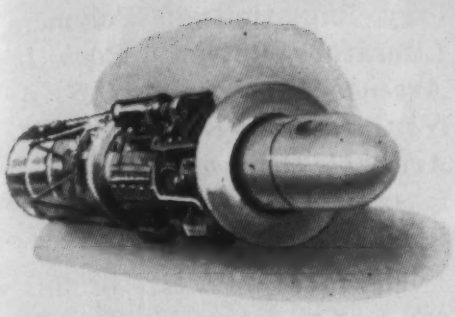
Research shows that hydrogen contamination in alpha-beta alloys can cause low ductility in slow strain rate, room temperature tensile tests, and premature brittle fracture in room temperature rupture tests. The combination of stress concentrations and hydrogen contamination can lead to a drastic decrease in the load carrying capacity of these alloys. Another result of hydrogen contamination is increased susceptibility to embrittlement as a result of exposure to stress and elevated temperature. At present, a maximum hydrogen content of 125 parts per million is suggested as a tolerance for aircraft quality alpha-beta titanium forging alloys. Data are presented which show that in the future it will be possible to produce alloys which have much higher tolerances for hydrogen.

High Temperature Rubber Development of a Rubber for Service in Contact with Experimental Hydraulic Fluids at 500 F. *Wright Air Development Center, Dec. 1954. PB 111598, 15 pp. Available from Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D.C. $.50.*

This report describes the testing, milling and compounding procedures used in developing a superior heat- and fluid-resistant rubber compound to function for long service periods, at temperatures ranging from —65 to 400 F, in the hydraulic systems of supersonic aircraft. Best results were obtained with compounds of Neoprene WRT aged in a silicate ester base hydraulic fluid developed under Air Force contract by a California research corporation. These compounds are believed to be processable on industrial equipment such as mills and extruders. Tables show comparative physical properties, both aged and original, of the various compounds tested and the experimental aging fluids used.

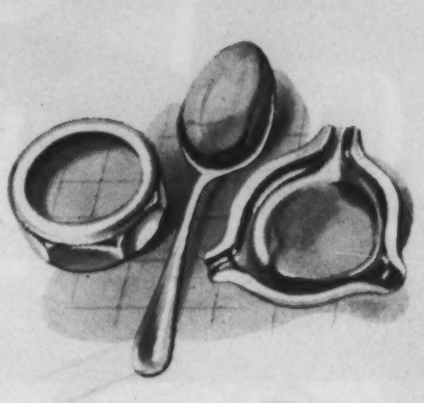
(More Reports on p. 190)

Today's uses for STRAITS TIN from MALAYA range from turbo-prop engines to pie cans

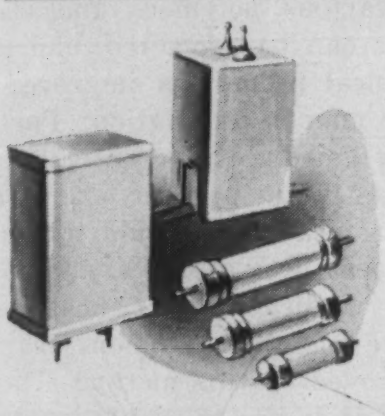


Turbo-prop engines in many modern aircraft have phosphor bronze bushings containing tin.

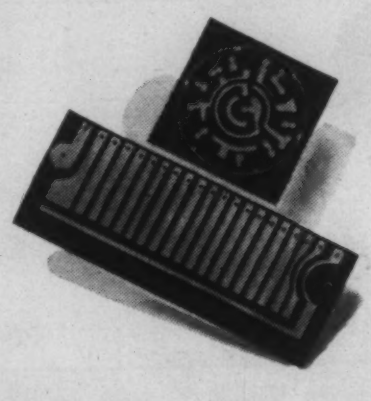
Soldering aluminum is made faster and easier by using new tin-rich tin-zinc-cerium solders.



New tin-nickel plating is both more corrosion resistant and more attractive than chrome.



Tin foil is again being used as the conductive element in many types of capacitors.



Printed circuits are a key factor in automation. Dip soldering saves time and costs.

Tasty beef and chicken pies can now be kept indefinitely in their new pie-pan-shaped tin cans.

Though one of the oldest metals known, we're still finding new ways to use tin. For perhaps no other metal can do so many different kinds of jobs so economically and so well.

Organotin chemicals, for example, are the best stabilizers known for polyvinyl chloride plastics. Tin-zinc and tin-cadmium plating alloys give steel greater corrosion protection than either zinc or cadmium alone. And, to cite just one more application, a new bearing alloy of aluminum and 20-30% tin has several times the strength of babbitt at working temperatures, with excellent antifriction properties.

Fortunately, there is plenty of tin. Over one-third of the world's supply is mined in Malaya, the key country in Southeast Asia. And with Malaya steadily winning its war against Communist guerrillas—with the new Manila Treaty and new U.S. Economic Aid Plans promising increased security against Communist infiltration in this important area—you can count on a supply of tin fully as dependable as the supplies of other materials produced in the Free World.

Straits Tin from Malaya is at least 99.87% pure—has been recognized as a standard grade for years. It is inert, nontoxic, friction and corrosion resistant. It can easily be plated in very thin layers, is highly malleable, has a relatively low melting point (450°F.). Above all, Straits Tin is economical to use—a little tin can do a lot of work. And there is a lot of work only tin can do. Whether you're planning a new product, improving an old one, or simply looking for ways to cut manufacturing costs, a careful reappraisal of the properties of Straits Tin may uncover a profitable answer to your problem.

A 20-page new booklet gives an informative report on Straits Tin and its many new uses today. Write for a free copy now.

Since February 1953, there have been no restrictions by the U.S. Government on the use of tin

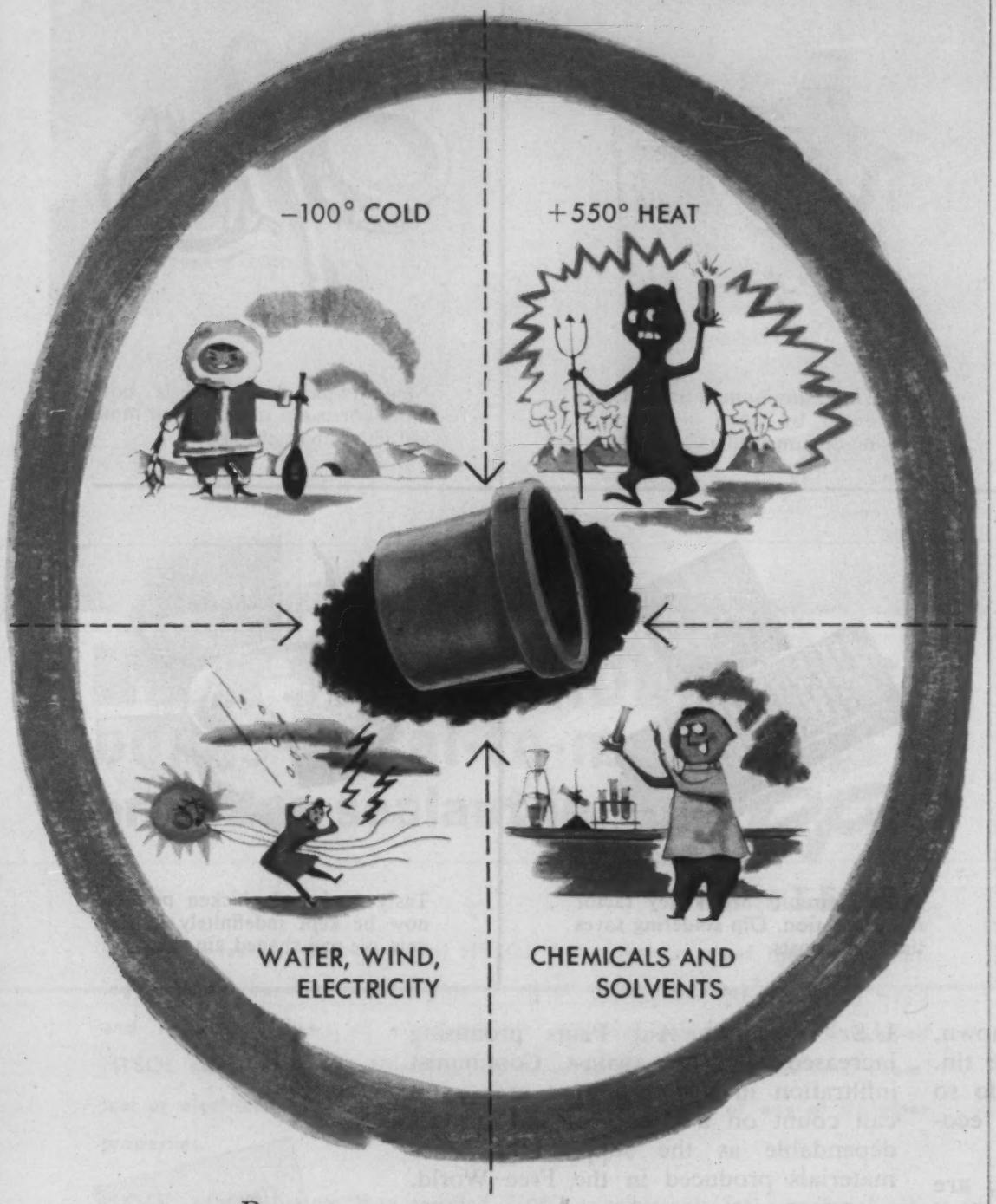
MALAYAN TIN BUREAU

The Malayan Tin Bureau

Dept. BB3, 1028 Connecticut Ave., Washington 6, D.C.

For more information, turn to Reader Service Card, Circle No. 348

A typical day for a rubber part molded from SILICONE by ROTH



Do you have a rubber part problem that can't be solved due to temperature extremes, weathering, resistance to chemicals or poor dialectric properties? If so, ROTH Rubber may have the answer in molded *Silicone* parts. It costs only a phone call or letter to find out if ROTH can solve your problem. Why not let ROTH work on it for you? No obligation.

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Write for your free Roth Rubber Sampler. This unusual kit contains actual rubber samples with hardness from 5 to 100 Durometer...gives ASTM specs and lists uses for each sample. Sorry, but offer must be limited to engineers and rubber buyers only. Please ask for Roth Rubber Sampler No. MM1.

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For more information, turn to Reader Service Card, Circle No. 479

Contents Noted

Reports . . .

Irradiated Polymers High Energy Radiation of Polymers, A Literature Review. *Rock Island Arsenal Laboratory, U.S. Army, Nov. 1953. PB 111529, 15 pp. Available Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D.C. $.50.*

The main objective of this survey was to determine the effect of irradiation of polymers on physical properties such as oil and heat resistance and aging. According to the literature, polymerization of various polymers and elastomers can be promoted, and their physical properties improved, by high energy irradiation. Particularly good results from experiments with polyethylene, which after irradiation could withstand temperatures of 250 C and above, have indicated that heat resistance of other rubbers may be improved by this method. The report discusses the techniques employed and the results obtained by irradiation of natural rubber, rubber vulcanizates, and numerous compounds.

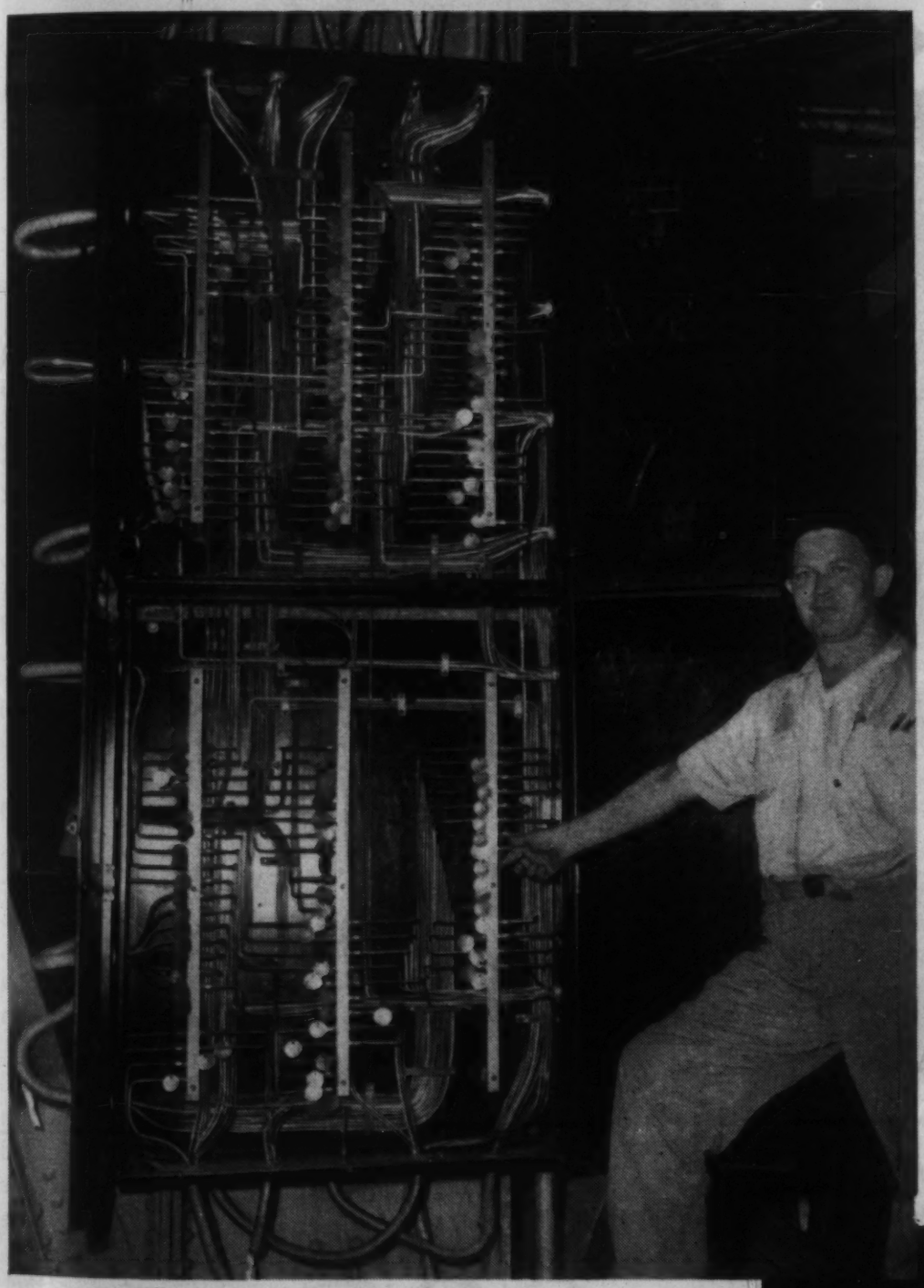
Steel Effect of Axial Dynamic Loads on the Mechanical Properties of Certain Steels. *R.C. Smith, T.E. Pardue, I. Vigness, U.S. Naval Research Laboratory, Dec. 1954. PB 116572, 20 pp, photos, drawings, diagrams, graphs, tables. Available from Library of Congress, Publication Board Project, Wash. 25, D.C. Microfilm $2.00, Photocopy $2.75.*

The influence of strain rate on the shape of stress-strain curves for hot- and cold-rolled low-carbon steel, ship plate, SAE 4140, and SAE 4340 has been investigated at NRL. Hot-rolled steel and ship plate exhibited dynamic yield values about 150 percent greater than the static yield points. The effect on the other materials was less pronounced. An attempt is made to correlate delay times for yielding under constant strain rates with values obtained in constant stress tests.

(More Reports on p. 192)

FOR INSTRUMENTATION AND CONTROL

Cabled Tube



Control Junction Box at Power Station of Long Island Lighting Company, showing use of Crescent Armored Multitube. Note that relatively sharp bends can be made without damage to the cabled copper tube.

Construction of Crescent Armored Multitube.

Some time ago Revere ran an advertisement featuring Crescent Armored Multitube for use in pneumatic and hydraulic instrumentation and control systems. The advertisement created so much interest that we thought you might like to see a photograph of an actual installation. The Control Board Junction Box shown here has 22 runs of Multitube coming into this box comprising 224 Revere Copper Tubes of 1/4" O.D. The picture was taken in the Glenwood Landing, N.Y. Power Station of the Long Island Lighting Company. The tubes go to instruments that report information on temperature, main and reheat steam pressure, boiler feed and condensate pump pressure, fuel oil and gas pressure, liquid levels, tide level and for the control of fuel feed, draft dampers, boiler drum water level and various control valves.

This is a relatively new use for Revere Copper Tube, but it is an important one in these days when new ways are being found to obtain process information more quickly and accurately, or to achieve automatic control. Crescent Armored Multitube is made by Crescent Insulated Wire & Cable Co., Inc., Trenton 5, N.J., in lengths up to 1,000 feet. It consists of a group of long tubes twisted together in cable form, protected by a flexible interlocked galvanized steel armor, or by plastic, or both. As many as 19 tubes, 1/4" O.D., can be cabled, with one tube in each layer color-coded. Larger tubes can also be cabled, including 5/16", 3/8" and 1/2". This construction affords protection during shipment, installation and use, and speeds up installation greatly. For further information, write Crescent, and for tube in copper and aluminum, see the nearest Revere Sales Office.

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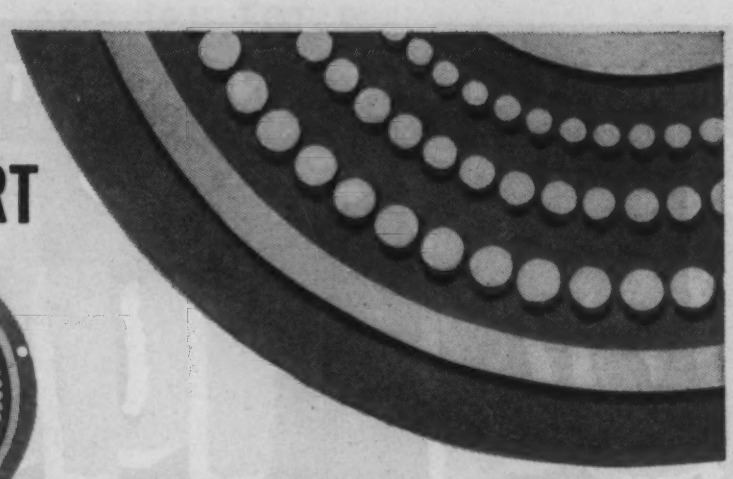
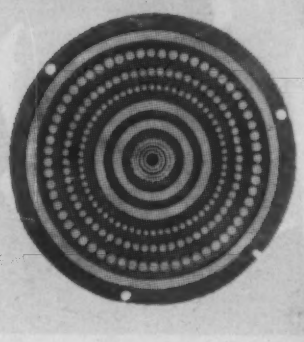
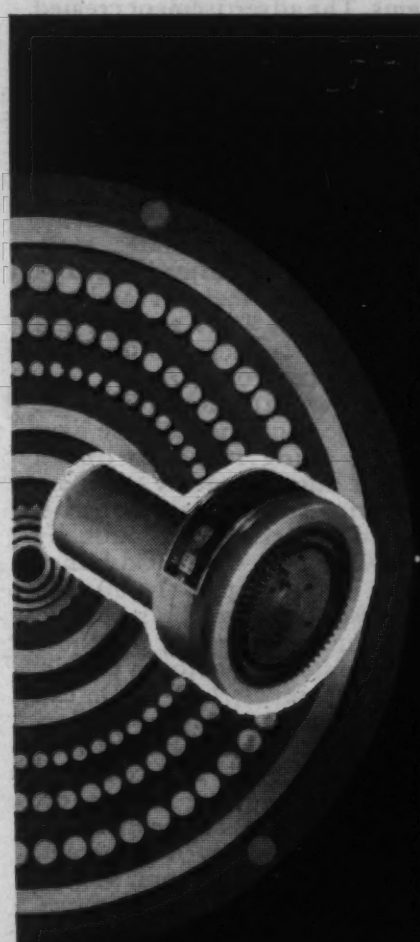


FIRST REPORT



MYCALEX®

TELEMETERING TESTS



1660 hours

of high quality switching at **600 rpm**

March 29, 1955:
After 1660 hours of operation, the new Mycalex Model TM-55 Series Commutator Switch continues to function with a perfect and unchanging signal. This initial continuous test run was halted only to permit a simple brush cleaning — and the life test resumed. Test goal — **10,000 hours!**

170 hours

of uniform operation at **1,800 rpm**

A second test — running concurrently — and using the new Mycalex Model TM-55 Series brush construction provided a clean signal for 170 hours at 1,800 rpm! Once again, operation was halted only to permit brush cleaning — and the test resumed.

Mycalex 410 provides:
- **absolute dimensional and age stability**
- **imperviousness to moisture**
- **precision dimensional tolerance control**
- **temperature endurance to 650°F.**

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MYCALEX ELECTRONICS CORPORATION

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Executive Offices
30 Rockefeller Plaza
New York 20, N. Y.

For more information, turn to Reader Service Card, Circle No. 481

Contents Noted

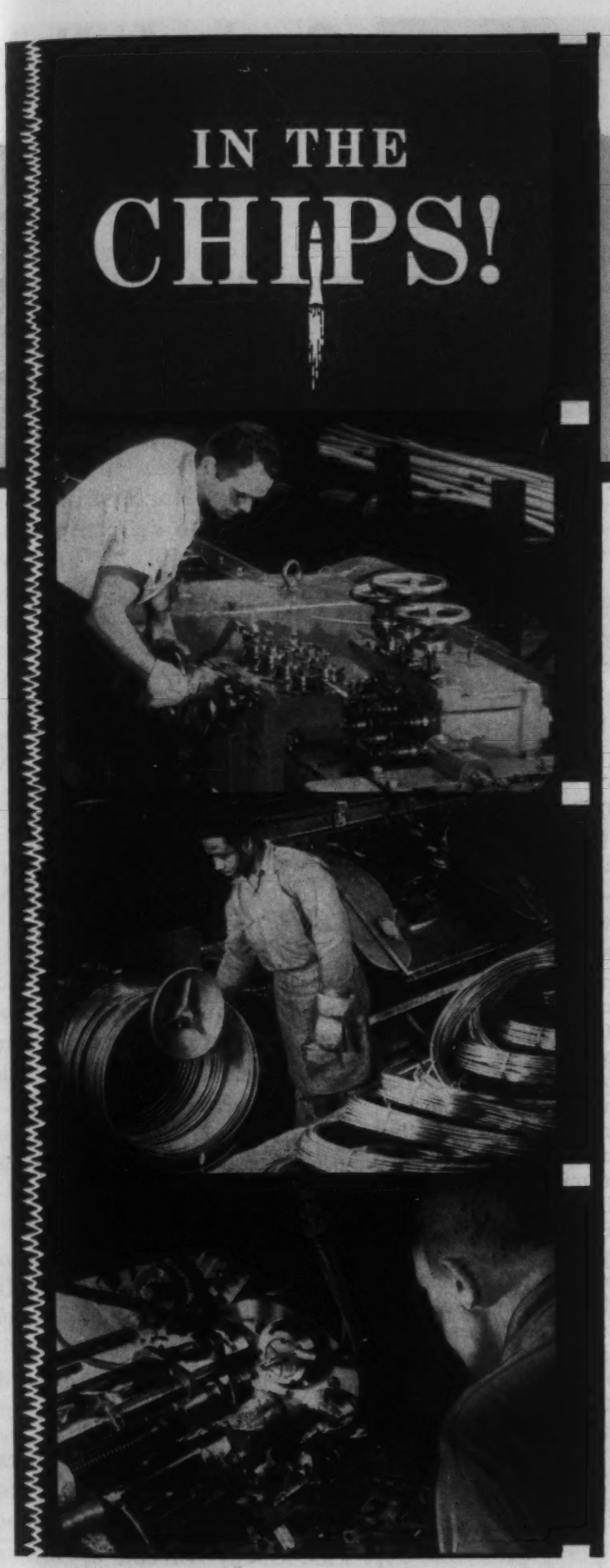
Reports . . .

Aluminum-Iron Alloy Fabrication Fabrication and Properties of 16-Alfenol, a Non-Strategic Aluminum-Iron Alloy. *J.F. Nachman and W.J. Buehler, U.S. Naval Ordnance Laboratory, White Oak, Md., Apr. 1953. PB 111552, 27 pp, photos, diagrams, graphs, tables. Available from Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D.C. $.75.*

The methods of fabricating 16-Alfenol from cast slab to thin gage tape are described in some detail. This fabricating information includes the operations of melting, casting, homogenizing, hot rolling, cold rolling at 575 C and room temperature, and thin gage rolling. Particular attention is focused upon the 575 C cold rolling of this material from the standpoint of the possible beneficial effects derived from an "ordering" type reaction occurring in Fe-Al type alloys. Cold reduction of 16-Alfenol from 0.007 to 0.0005 in. was accomplished at room temperature on a small Rohn mill.

Melting Titanium Metallurgical evaluation of Refractory Compounds for Containing Molten Titanium. Part III: Borides and Sulfides. *E.J. Chapin and W.H. Friske, U.S. Naval Research Laboratory, Jan. 1955. PB 116626, 34 pp, photos, drawings, diagrams, graphs, tables. Available from Library of Congress, Publication Board Project, Wash. 25, D.C. Microfilm $2.50, Photocopy $5.25.*

Diborides of Ti, Zr, and Cr in crucible form were investigated for melting titanium. In all cases the molten titanium reacted with the crucible at the interface to produce general solution attack and to cause severe contamination of the metal with brittle boron compounds. Solution of the reaction products resulted in an increase in melting point, making pouring difficult. These borides are not considered promising as crucible materials. CeS was also investigated in crucible form. General solution attack of the



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FIRM _____

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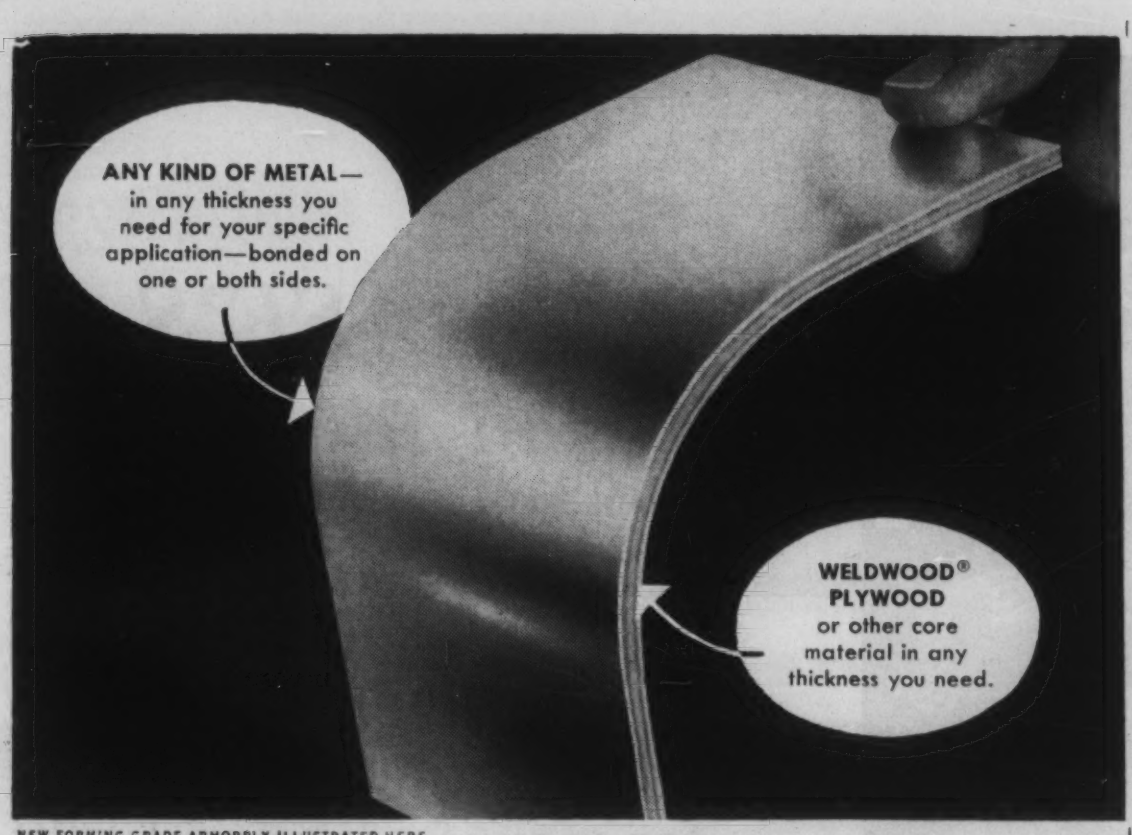

NEW FORMING GRADE ARMORPLY ILLUSTRATED HERE.

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Metal Faced Plywood

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Weldwood Armorply* stirs the imagination of designers and fabricators. Many new uses are being found for this versatile product.

WHAT IS ARMORPLY? It's Weldwood plywood or other core material to which metal has been permanently bonded on either or both faces by a special technique. It combines the best features of plywood (it's strong, light in weight, easily fabricated) with the natural advantages of metal (toughness, impact resistance, fireproofness, long life). Any metal in any thickness can be successfully bonded to a variety of cores in any thickness.

WHAT ARE ITS BENEFITS? Because of the bonding process, much thinner gauge of metal can be used. This results in substantial material savings per square foot—particularly with stainless steel—plus fabricating savings. You get a more rigid panel; the metal is perfectly flat and does not show undulations as in the case of metal alone.

USES OF ARMORPLY. Manufacturers are increasingly using Armorply for dozens of uses such as truck bodies, pallets, walk-in and reach-in refrigerators, elevator cabs and doors, tote boxes, counter tops. But new uses are constantly being discovered. For instance, lead in ¼" thickness was employed as a facing for an Armorply wall recently erected in an X-ray room.

A NEW ARMORPLY. Forming grade Armorply is a new type of this product with a great potential. It is ⅛" thick and consists of a 1/10" core of single ply veneer plus metal skins. Any metal can be used, but aluminum is particularly successful. This material can be rolled into single curvature shapes, bent to right angles using standard metal working tools; can be die-cut, punched or perforated.

WHAT'S YOUR PROBLEM? There are unlimited possibilities for cutting costs and speeding production with Armorply. The Special Products Division of the United States Plywood Corporation is ready to assist you.

*Trade Mark

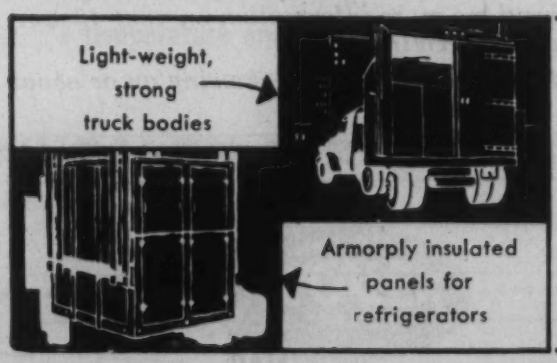
Armorply

METAL FACED WELDWOOD PLYWOOD

ARMORPLY

A Product of

UNITED STATES PLYWOOD CORPORATION



United States Plywood Corporation
55 West 44th Street
New York 36, N. Y. M 7-5

FREE: Please send me free sample of Armorply and descriptive literature. ( )
Please have a salesman call with full details. ( )

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CITY.....STATE.....

For more information, turn to Reader Service Card, Cirle No. 414

Contents Noted

Reports . . .

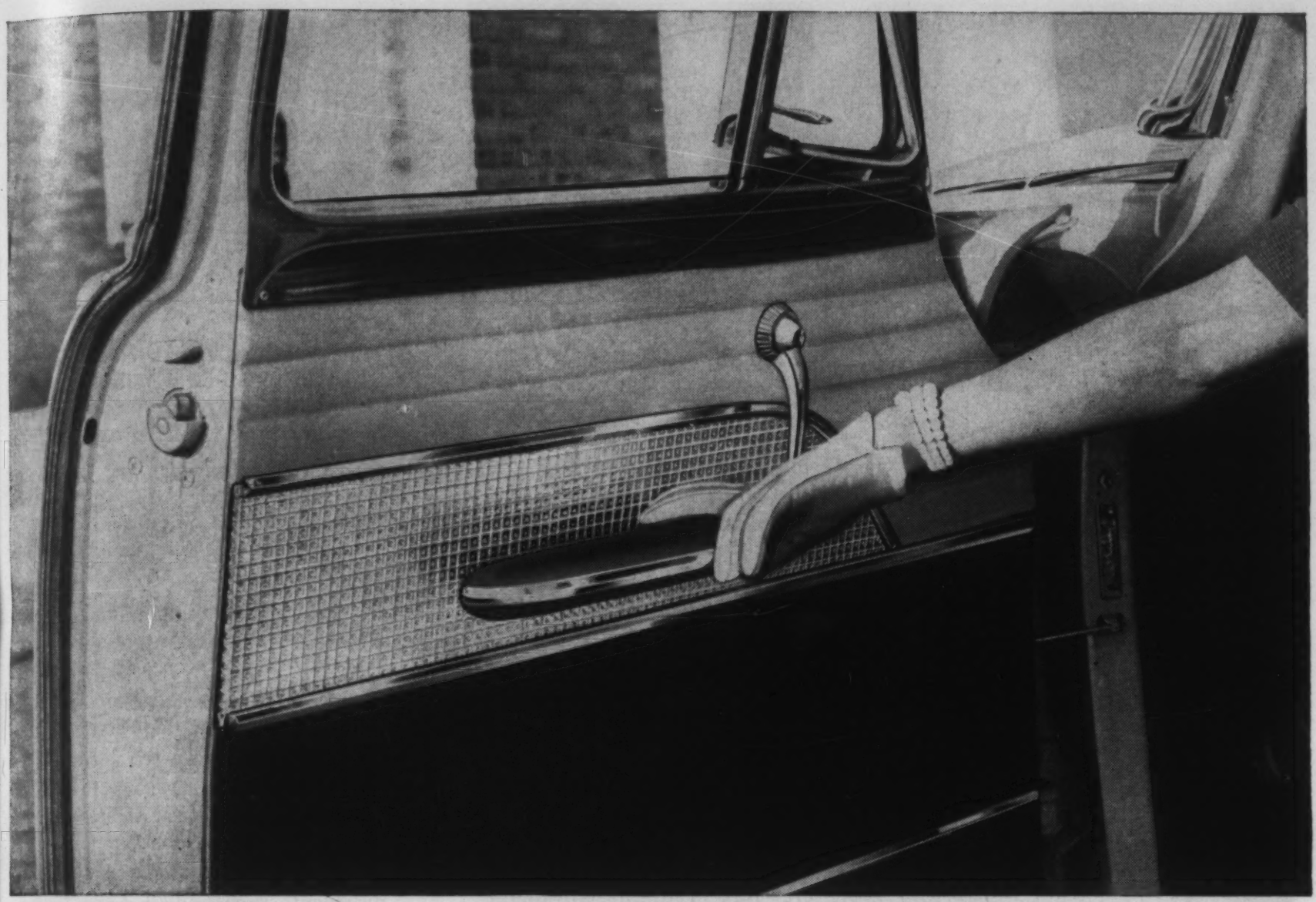
crucible occurred with contamination of the titanium melt. Metallographic and chemical analytical evidence indicates a binary eutectic system between Ti and CeS. In spite of the appreciable contamination with sulfur the hardness level was increased only moderately. Further investigation is required to determine if larger crucibles would be beneficial in minimizing sulfur pickup by the molten metal.

Brazed Joints Preliminary Investigation of Properties of High-Temperature Brazed Joints Processed in Vacuum or in Molten Salt. *C.A. Gyorgak and A.C. Francisco, May 1955. NACA TN 3450, 29 pp, diagrams, photos, 7 tables. Available National Advisory Committee for Aeronautics, 1512 H St., N.W., Wash. 25, D.C.*

An investigation was conducted to determine the effect of the variables temperature, time at temperature, and nickel addition to the braze alloy on the shear strength of high-temperature-alloy brazed joints processed in vacuum or in molten salt. Both brazing methods produced shear strengths greater than those of joints processed in dry hydrogen. Vacuum brazing was superior to salt-bath brazing, average shear strengths, being on the order of 63,000 and 48,000 psi, respectively.

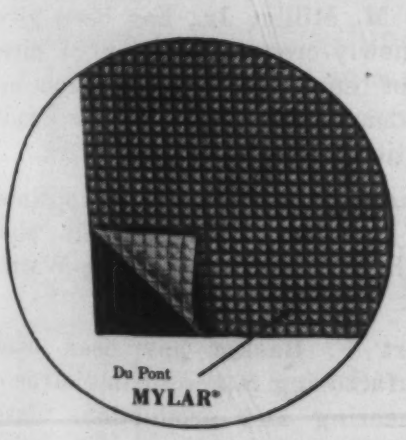
Zirconium Inspection Ultrasonic Inspection of Arc-Cast Zirconium and Its Alloys. *F.W. Wood, and J.O. Borg, Bureau of Mines, Report of Investigations 5126, Mar. 1955.*

Report describes Ultrasonic Testing equipment for determining soundness of zirconium ingots. Inclusions, voids, porosity, and discontinuities may be located in ingots up to 48 in. in length. Equipment requires minimum of maintenance or internal adjustment, and may be operated by non-scientific personnel. Small addition of alloy does not require special techniques.



Interior design improvements in late-model cars

made possible by NEW DU PONT MYLAR*



Style-conscious designers are achieving new beauty . . . new economies in auto-interior trim . . . with a new kind of decorative surfacing material made possible by Du Pont "Mylar" polyester film. This thin, tough, transparent film —which resists abrasion, oils, solvents, chemicals—can be metalized in a full range of subtle colors. Bonded to a backing, then embossed, metalized "Mylar" offers a rich-glinting variety of decorative side-door panel inserts, seat-welt trim, package-tray covers and kick panels. And designers estimate that the cost of these new and striking effects for auto interiors is 40% less than the material formerly used!

This new decorative surfacing material is highly resistant to abrasion. Oil and grease have no effect on it. It can be wiped clean without smearing. Other uses now in development include wall surfacings, leather goods, book covers, kitchen appliances.

Find out more about new materials made with "Mylar." Mail the coupon for new booklet and samples.

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Film Department, Room 7T, Nemours Bldg.
Wilmington 98, Del.

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*Firm Name*_____

*Street Address*_____

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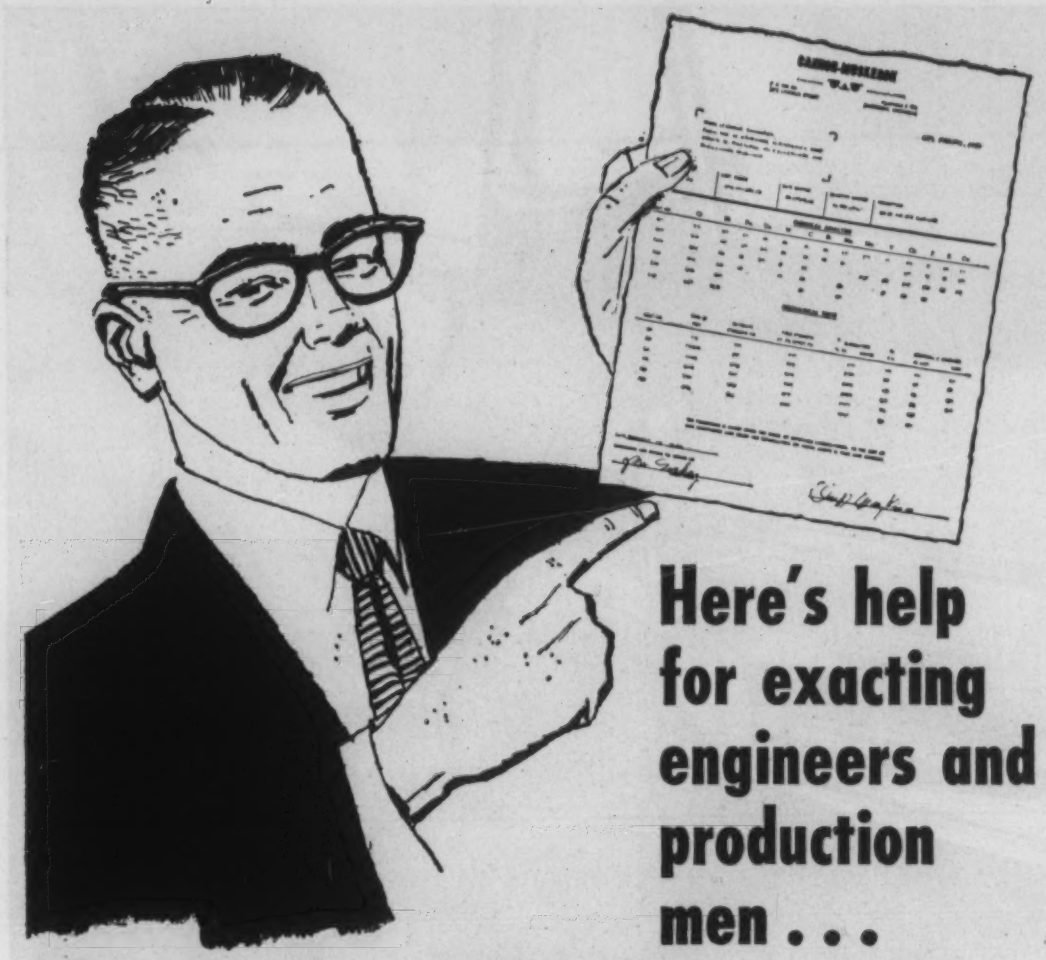
For more information, turn to Reader Service Card, Circle No. 373



Here's help for exacting engineers and production men . . .

who must be absolutely right about metal analysis

WITH each MasterMet alloy you buy, Cannon-Muskegon gives you a certified, notarized analysis . . . black-on-white proof that MasterMet alloys are produced exactly to your specifications. This assures close predictable control of physical and chemical characteristics for any end-use. You can be confident that the results you plan — the performance you call for will be delivered in parts made with MasterMet alloys.

You can choose from a wide range of high alloys including cobalt-base and nickel-base alloys, chromium and chromium nickel stainless steels. Also included are such special alloys as Monel*, Inconel*, Invar, Ni-Resist*. Order these types or your custom specifications from Cannon-Muskegon.

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MasterMet alloys are available in shot, ingots and cast billets, bars and special shapes. Often the more common low alloy and 300 and 400 Series stainless steels can be shipped from stock. Remember . . . whatever your needs, Cannon-Muskegon can provide metallurgical engineering assistance in recommending the proper alloy — as well as the proper handling — to assure the best possible casting. Write for bulletin!

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news of ENGINEERS COMPANIES SOCIETIES

NEWS OF ENGINEERS

John Thomas has been appointed assistant to **Admiral Wilson D. Leggett, USN, ret.,** new vice president of engineering, ALCO Products, Inc.

William D. Heavner, Jr., has been made research chemical engineer in corrosion in the Stainless Steel Research Section, Allegheny Ludlum Steel Corp.

Dr. Henry Carroll has joined Allis-Chalmers Manufacturing Co.'s Research Div.

Frank W. Glaser has been made a vice president and director, Alloy Precision Castings Co.

Harry C. Platt has been appointed president, Engineered Castings Div., American Brake Shoe Co.

McClure Kelley has been elected president, the Baldwin-Lima-Hamilton Corp., to succeed **Marvin W. Smith,** who becomes chairman of the Executive Committee.

H. Maurice Banta and **Loran S. O'Bannon** have been named technical advisers, Battelle Memorial Institute.

John M. Miller, Jr., has been given the newly-created position of director of engineering, Television and Broadcast Receiver Div., Bendix Aviation Corp.

Emmett Geibel has been appointed chief engineer, Effingham, Ill., plant of the Norge Div., Borg-Warner Corp.

Robert F. Baskin has been made manufacturing manager in charge of engineering and production, Cleveland Instrument Co.

Ralph L. Bayless has been named chief engineer of Convair, a Div. of General Dynamics Corp. Other new appointments by the company include **Adolph Burstein** as assistant chief engineer and **S. G. Frank Haas, Jr.** chief development engineer.

Arthur R. Lytle has been made vice president in charge of research, Electro Metallurgical Co., a Div. of Union Carbide and Carbon Corp.

R. K. Buffington has been appointed sales manager, General Plastics Corp. Mr. Buffington was formerly

Stainless steel sheathing will soon cover 42 stories containing 1,300,000 square feet of office space in New York's newest skyscraper—the Socony Vacuum Building—by Spring of 1956.

Is stainless steel coming your way, too? It's strong . . . light . . . corrosion resistant. It serves both as a structural and decorative material. And a little goes a long, long way.

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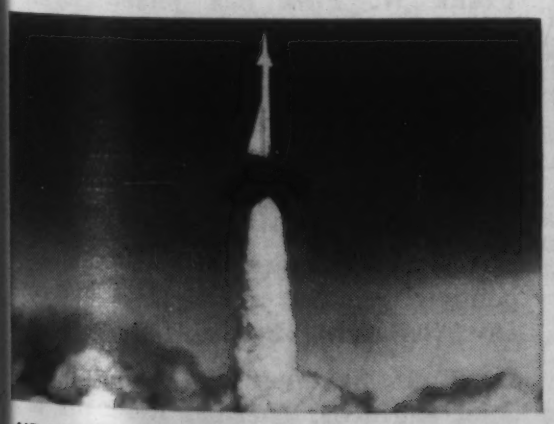
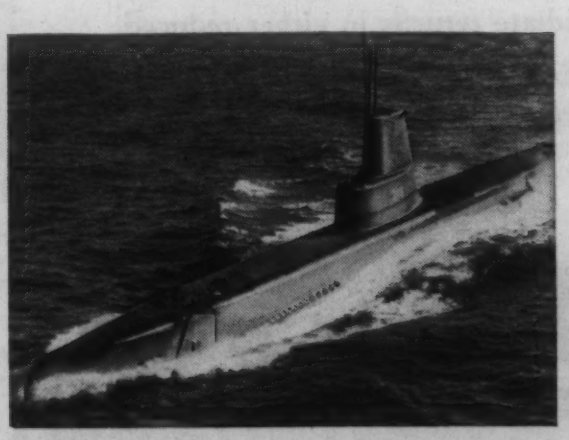


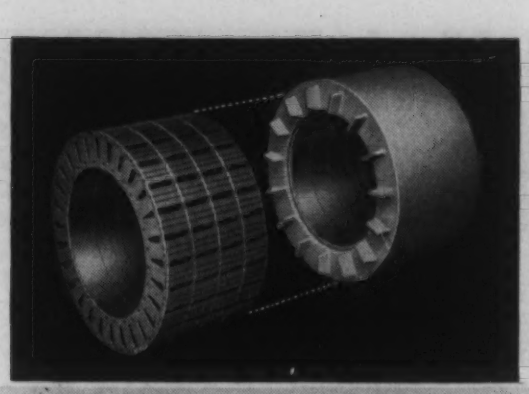
UP-UP to outer space are modern rockets with engine parts of special stainless, heat-resistant steels—made with Vancoram Exlo® Low-Carbon Ferrochromium.



DOWN-DOWN to new diving depths are modern submarines with hull plates and structural members made of high-strength alloy steels to hold back tons of sea water.

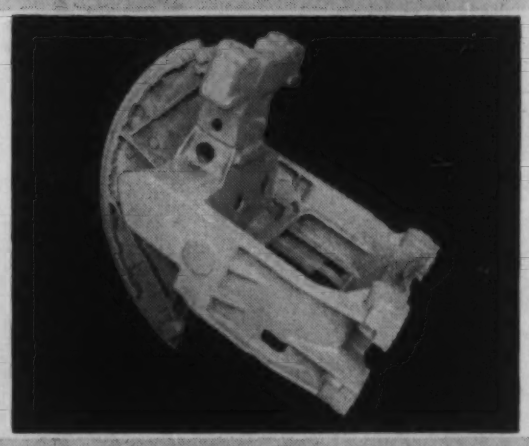
STRAIGHT AHEAD and plenty fast are modern trains where diesels and passenger cars depend on alloy steels for critical operating parts, stainless for longer lasting bodies.

For more information, turn to Reader Service Card, Circle No. 318



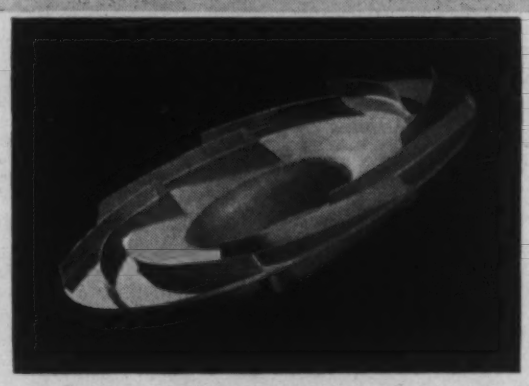
MAGNETIC OUTPUT BOOSTED 10% BY ROLLE MFG. CO.

Rolle advanced casting techniques keep permanent magnet insert temperatures down, yet assure a sound permanent mold aluminum casting. As a result, magnetic output of this alternator rotor is up 10% over best previous attempts.



NIGHTMARE SPECIFICATIONS MET BY ROLLE MFG. CO.

Complicated internal structure, unequal wall sections, complex wall joinings, intricate internal webbing, make feeding and chilling stressed areas a nightmare in this sand casting. But Rolle Manufacturing is turning out castings able to pass 100% X-ray examination to highest aircraft standards in production quantities.



CASTING COSTS CUT 44.5% BY ROLLE MFG. CO.

Rolle recommended change from sand casting to permanent mold casting of this part, with guaranteed surface in required areas, between fins, of from 100 to 125 microinches. Change resulted in casting costs down 44.5%, and machining time cut in half.

ROLLE CAN SOLVE YOUR CASTING PROBLEMS

Your casting problems—sand or permanent mold, aluminum or magnesium alloys—can always be solved quickly and economically if you bring them to Rolle. But the advantages of fighting weight with strength with Rolle don't stop there. Some of the most impressive savings Rolle has made for customers involved castings that were never considered "problems."

You can get some idea, just from the few cases illustrated here, of how the use of advanced techniques . . . a change in casting method . . . variation in any of a hundred casting considerations, can bring immediate returns in either reduced costs or improved performance, or both.

Write now for a free booklet that tells how you can solve casting problems with Rolle.

FIGHT WEIGHT WITH STRENGTH with **ROLLE MANUFACTURING COMPANY**

Cannon Avenue Lansdale, Penna.

For more information, turn to Reader Service Card, Circle No. 382

news of ENGINEERS

assistant sales manager, Royalite Div., United States Rubber Co.

Dr. Arthur G. Metcalfe has been promoted to senior metallurgist, Armour Research Foundation of Illinois Institute of Technology.

Harold B. Emerick has been named director, Technical Services Div., Jones & Laughlin Steel Corp.

Andrew Fletcher, president, St. Joseph Lead Co., has been elected president, Lead Industries Assn.

Patrick V. Gallagher has been appointed chief engineer, Dwight-Lloyd Div., McDowell Co., Inc.

R. C. Mahon, formerly president, the R. C. Mahon Co., has been elected chairman of the board.

Dr. J. E. Stareck has been made director of research, Metal & Thermit Corp. Dr. Stareck will also continue to direct the research activities of United Chromium, Inc., a subsidiary of Metal & Thermit.

H. M. Dardani has recently been appointed vice president for manufacturing, and **R. H. Carter** has been named chief engineer, Miniature Precision Bearings, Inc.

John M. Wilson has been made chief engineer, Development and Design Div. of the Engineering Department, Minneapolis-Honeywell Regulator Co.'s Brown Instruments Div.

C. H. Kimmel has been elected president, the Ohio Crankshaft Co.

Stuart E. Weaver has been elevated to the position of vice president in charge of engineering, Radioplane Co., a subsidiary of Northrop Aircraft, Inc.

Dr. B. T. Collins has been appointed product development engineer, Wabash Div., Raybestos-Manhattan, Inc.

Frank W. Fink has joined Ryan Aeronautical Co. as vice president and chief engineer.

Norman Gray has been made staff assistant to the president and **Eric Bylund,** director of research and engineering, Schick, Inc.

Harry M. Zimmerman has been appointed general manager, Plastics Div., Seiberling Rubber Co.

Dr. E. H. Seymour has been named chief engineer, Thermal Research & Engineering Corp.

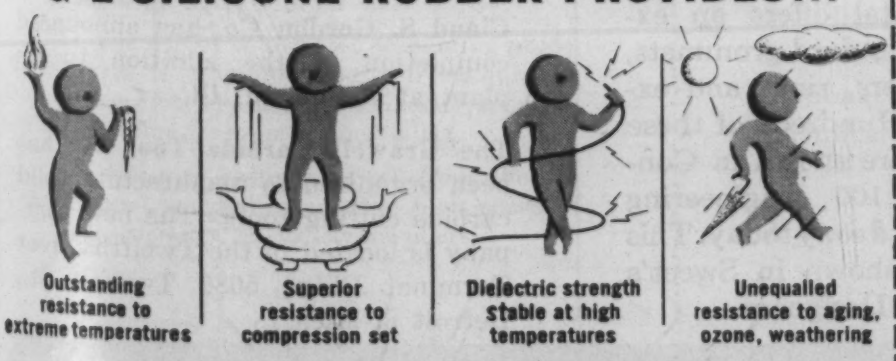
Tinius Olsen II has been elected president, Tinius Olsen Testing Ma-

How can you benefit from the AMAZING "COME-BACK" of G-E SILICONE RUBBER?

Amazing recovery from compression is one of the most useful characteristics of General Electric silicone rubber. In fact, Class 300 silicone rubber has more "come-back" over a wider temperature range than any known rubber! That's why designers now use it where compression is a factor. They know that O-rings and gaskets made of Class 300 silicone rubber *resist compression set*—give *more positive* sealing action for better performance!

Where can YOU use G-E silicone rubber? There's a kind for almost every requirement, classified according to dominant property for easy selection and specification. For example: Class 500 offers flexibility *at 120 F below zero!* Class 700 provides serviceability *up to 600 F!* Which class of G-E silicone rubber is best for *you?*

G-E SILICONE RUBBER PROVIDES...



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Dielectric strength stable at high temperatures

Unequalled resistance to aging, ozone, weathering

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1 ( ) Molded gaskets, bushings
2 ( ) O-rings
4 ( ) Shock mounts
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13 ( ) Die-cut gaskets
Other_____

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Firm_____

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IN CANADA: Mail to Canadian General Electric Company, Ltd., Toronto

For more information, turn to Reader Service Card, Circle No. 333

Photo courtesy American Sterilizer Co., Erie, Pa.

"Just What the Doctor Ordered"

New Super-Soft Rubber Pads Developed for Surgical Table Headrest

This surgical patient's head is in firm but gentle hands. The tight grip of the surgical table headrest shown above is now cushioned by super-soft (20 durometer) solid rubber pads. These pads are almost as soft as sponge but can be decontaminated and sterilized far more easily. Being made of neoprene, they are unaffected by oils, acids or decontaminating and sterilizing solutions. Furthermore, repeated sterilizing in live steam does not cause excessive hardening.

The neoprene compound specially developed for this purpose is 10 to 15 durometer points softer than normal commercial limits. For that reason, special care and skill must be taken in mixing and molding.

The successful development of this special purpose rubber part typifies the complete engineering and laboratory—as well as manufacturing—service offered by Continental.

Why not let Continental engineers consult with you in the planning or blueprint stage? Their specialized skill might help you get better rubber parts for your requirements.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these standard parts are shown in Continental's No. 100 Engineering Catalog. Send for a copy today. This catalog also is shown in Sweet's File for Product Designers.

Another achievement in **RUBBER**

(CR) *engineered by* **CONTINENTAL**

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news of | ENGINEERS

chine Co. He succeeds his father, **Thorsten Y. Olsen,** who was elevated to chairman of the board.

Eugene H. Kinelski has joined the Development and Research Div., the International Nickel Co., Inc., as research metallurgist in the Welding Section of the Research Laboratory.

Robert C. Overstreet has been made president, Tinnerman Products, Inc.

Dr. Augustus B. Kinzel, formerly director of research, Union Carbide and Carbon Corp., has been elected vice president of research for the company.

news of | COMPANIES

Acushnet Process Co. has opened its new plant in conjunction with its 45th anniversary.

Chem-Etched Circuits, Inc., 121 S. Cowen St., Garrett, Ind., has been formed to design, develop and manufacture etched circuits by the photoengraving method.

Continental Can Co.'s purchase of the patents and production facilities of **Vaporized Metal Coatings, Inc.,** has been approved by the directors of the two companies.

Cornell-Dubilier Electric Corp. has announced the formation of a Printed Wiring Div. at South Plainfield, N. J., devoted exclusively to the design, development and manufacture of printed circuitry.

General Electric Co. has opened its new multi-million dollar manufacturing plant in Waynesboro, Va. The new plant will be headquarters for the company's Specialty Control Department.

Claud S. Gordon Co. has announced completion of the addition to its plant at Richmond, Ill.

The **Grawell Carbide Tool Co.** has been organized to manufacture solid carbide cutting tools. The new company is located in the Twelfth Street Terminal Bldg., 5680 Twelfth St., Detroit 8, Mich.

Mullins Manufacturing Corp. has completed installation of equipment to produce projectiles by its Koldflo process of cold extrusion at the Naval Industrial Reserve Ordnance Plant, Hays, Pittsburgh.

National Research Corp. has received

83% saving with Gray Iron

A saving of over 80% on original cost by redesigning in Gray Iron! Also, longer life and improved operating characteristics are provided by the cast part.

This happens every day... someone decides to adopt Gray Iron and confirms its engineering advantages. Have you?

Call your nearest Society member foundry and the full facilities of this association will be available to help you. Or, write direct to Gray Iron Founders' Society, Inc., National City-E. 6th Bldg., Cleveland 14, Ohio, for helpful technical and business information.

MAKE IT BETTER WITH GRAY IRON

This symbol assures you the most for your casting dollar

Here's why it pays to call in one of the more than 500 leading foundries displaying the Society symbol:

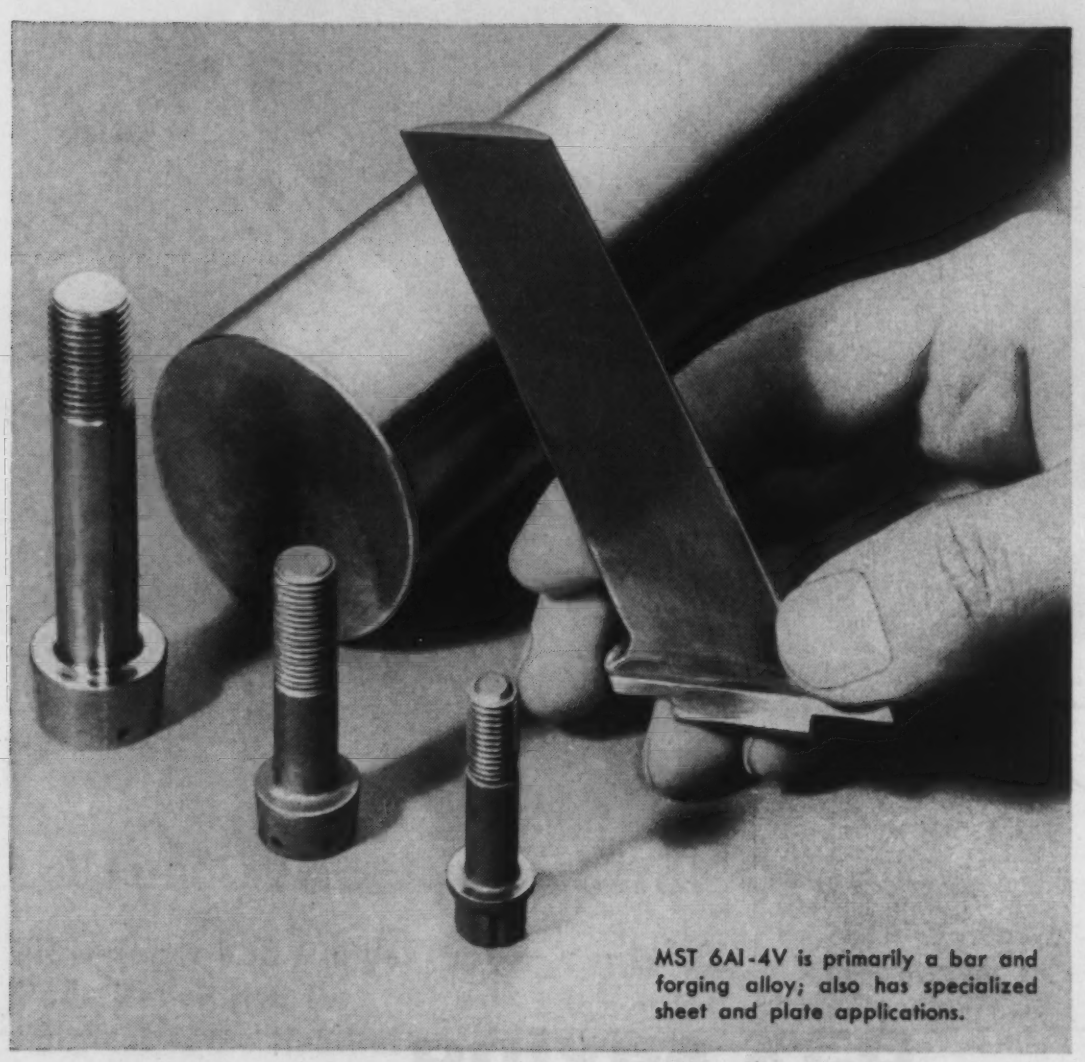
- The most recent technical and business information is available to each member through the Society to help you design better products at lower cost.
- The use of sound cost accounting procedures is recommended and encouraged among Society member foundries, assuring full value for your casting dollar.
- Improved castings result from the advanced techniques and the high sense of responsibility of Society members.

GRAY IRON FOUNDERS' SOCIETY

For more information, turn to Reader Service Card, Circle No. 339

MALLORY·SHARON reports on

TITANIUM



MST 6Al-4V is primarily a bar and forging alloy; also has specialized sheet and plate applications.

NEW MST ALLOY
"stays put" at high temperatures

● The problem of elevated temperature embrittlement present with many titanium alloys has been overcome with this newest development. MST 6Al-4V (6% aluminum, 4% vanadium, balance titanium) can be used at temperatures up to 750°F with minimum creep or change of properties. It has excellent strength and stability at high temperatures, is relatively insensitive to notches, and can be hot worked over a wide range. It can be readily machined, welded, or heat treated.

Like all Mallory-Sharon alloys, MST 6Al-4V is vacuum double melted, assuring homogeneity and consistent quality. Specify it for consistent, predictable, high temperature performance. A bulletin listing complete data is yours for the asking. Write Mallory-Sharon Titanium Corporation, Dept. G-7, Niles, Ohio.

MALLORY Ti SHARON

For more information, turn to Reader Service Card, Circle No. 466

news of | COMPANIES

a contract for $1,183,495 from General Services Administration to finance construction and operation of a demonstration pilot plant for production of titanium metal by a new non-Kroll process developed by the company. The plant will be housed in a building being erected in Newton, Mass.

South Chester Corp.'s Southco Div. has announced the purchase of the working assets of **Lion Fastener, Inc.**

The **F. W. Wakefield Brass Co.** has changed its corporate name to the Wakefield Co.

The **White Motor Co.** has acquired the property, business, inventory and other assets of the **Diesel Engine Div., the National Supply Co.**

Superior Tube Co. has acquired a majority interest in **Johnson & Hoffman Manufacturing Corp.**

Standard Machinery Co. has completed the sale of its molding press business to a newly-formed and completely separate company, the Hull-Standard Corp., Abington, Pa.

St. Regis Paper Co. has announced the acquisition of the assets, including all equipment, of the Plastics Div., **Kline Manufacturing Co.**

The **Budd Co.** has purchased most of the assets of the **Continental Diamond Fibre Co.**, which will be known as the Continental-Diamond Fibre Div. of the Budd Co., Inc. The plant in Marshallton, Del., which manufactures Haveg, chemical-resistant plastics, and will probably be known as Haveg Industries, Inc., was not included in the transaction.

Dumont Aviation Associates has purchased the business of **Industrial Associates, Inc.**

Bostitch, Inc., has made plans to move its main manufacturing plant and general offices to East Greenwich, R. I., where a new and larger factory will be built.

news of | SOCIETIES

The **American Foundrymen's Society**, at its recent annual meeting, elected Bruce L. Simpson, president, National Engineering Co., as president and Frank W. Shipley, foundry manager, Caterpillar Tractor Co., as vice

from VACUUM MELTING–
improved alloys with exceptional properties

WHAT ARE VACUUM-MELTED METALS?

Vacuum-melted metals are a familiar family of alloys with new, improved characteristics. For during high-vacuum melting, gaseous impurities are literally sucked from the molten metal. The result is cleaner, purer metals with desirable properties not previously attainable . . . in, for example, superalloys, bearing steels, high-strength steels, electronic metals, or magnetic alloys.

WHAT ARE THEIR ADVANTAGES?

Many characteristics of a specific alloy can be improved by vacuum melting and casting . . . for impurities that limit an alloy's potential are removed. Tensile and impact strength, stress rupture strength at elevated temperatures, and fatigue life can all be substantially improved . . . and creep and brittleness minimized by vacuum melting.

HOW CAN I BEST USE THESE IMPROVED ALLOYS?

Frankly, vacuum-melted metals are so new that many applications for them have not yet been explored. But where they have been used, they've *proved* their effectiveness in improved performance. Superalloy jet engine turbine blades, for example, have given more than *twice* the performance life of blades made of conventional air-melted alloys. And ball bearing rejects dropped from 50% to 3% when vacuum melted steels were used.

WHERE CAN I GET VACUUM-MELTED METALS?

Now, Vacuum Metals Corporation, pioneer in the development and production of vacuum-melted and cast alloys, is producing tool, high-speed, stainless and alloy steels – in most sizes and grades – as well as special ferrous and nonferrous alloys. If you have a metals problem that vacuum-melted alloys might solve, please describe it in as much detail as possible. Write *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, N. Y.*

VMC

VACUUM METALS CORPORATION

Jointly owned by Crucible Steel Company of America and National Research Corporation

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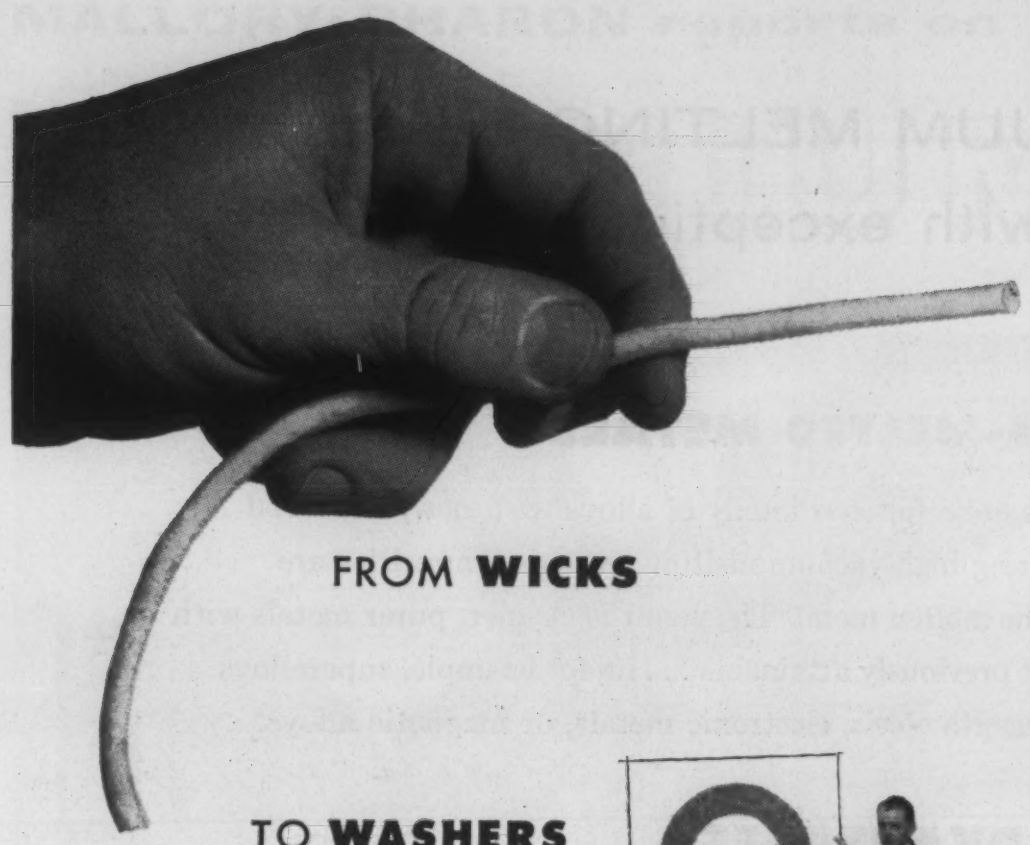
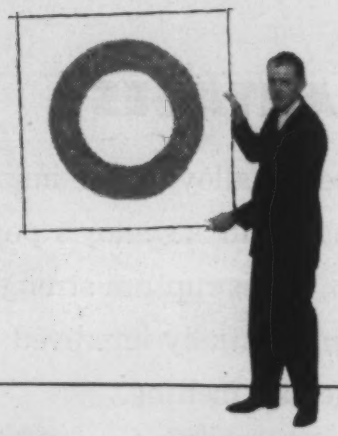


FROM **WICKS**

TO **WASHERS**



FELT

by FELTERS

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Wicks that pull oil in — washers that keep dirt out — are two of many jobs done by Felters Felt, to keep equipment in good operating condition.

Hard enough to be ground and chiseled, soft enough to buff a jewel — or any texture in between — each shipment of Felters Felt is uniformly controlled to exactly meet your specs.

The "Felters Design Book" contains interesting information about several grades of Felt and their uses. We will be glad to send you a copy. Write today. THE FELTERS CO., 220 South St., Boston 11, Mass.

FELTERS S.A.E. F-1 FELT

is a grade suitable for oil retention where the felt is not compressed, for feeding light oil, or where unusual strength and hardness are required. Often recommended for use in resisting wear and abrasion.

This is one of many grades of Felters Felt produced for specific applications.

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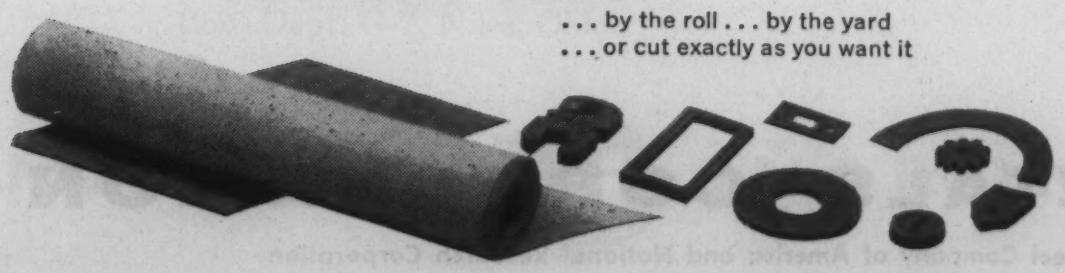
. . . or cut exactly as you want it



For more information, turn to Reader Service Card, Circle No. 448

news of | SOCIETIES

president. In addition, the Society has honored three men with its highest awards: to John B. Caine, the John H. Whiting Gold Medal "for outstanding contributions to the Society and the industry, particularly in the field of foundry sand research and applications"; to John Edward Rehder, the Peter L. Simpson Gold Medal "for outstanding contributions to the Society and to foundry knowledge of cast metals"; and to Robert F. Thomson, the John A. Penton Gold Medal "for outstanding contributions to the Society and the industry in foundry research, particularly in the field of light metals".

The **American Iron and Steel Institute** Medal has been awarded to Arthur P. Woods, Jr., research engineer with Armco Steel Corp., for his paper, "Some Statistical Methods Used in Studies of Steel Plant Operations". The Institute has also presented its Regional Technical Meeting Award to Dr. E. F. Osborn, dean, College of Mineral Industries, the Pennsylvania State University, for his technical paper, "Phase Equilibrium Studies of Steel Plant Refractories Systems".

The **American Society for Engineering Education** has moved its editorial offices to the University of Illinois. Dr. Lisle Rose, professor of general engineering and director of engineering information and publications, has succeeded Professor Clarence Watson of Northwestern University as editor and will also serve as ASEE public relations director.

The **American Society of Body Engineers** has announced that its 10th Annual Technical Convention will be held Oct. 26-28, 1955, in Detroit, Mich.

The **American Society of Tool Engineers** has appointed the following new national committee chairmanships for 1955-56: Vincent M. Spahr, Constitution and By-Laws; H. Verne Loeppert, Membership; Walter F. Wagner, Honor Awards; Leslie C. Seager, Professional Engineering; Philip R. Marsilius, Program; Wilfred B. Wells, Public Relations; and William Moreland, Standards.

The **American Society of Mechanical Engineers** has announced that its nominee, Dr. Igor Sikorsky, received the Institute of Mechanical Engi-

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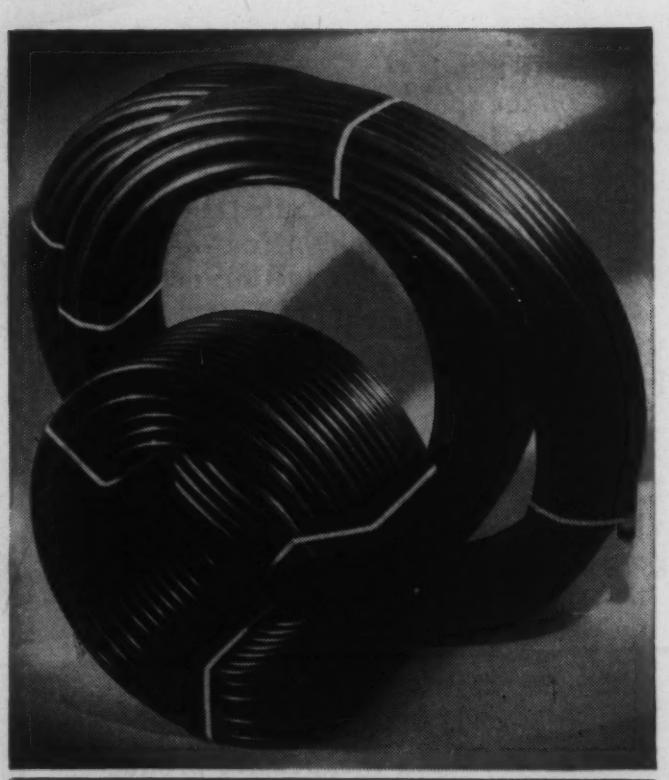
USS NATIONAL PLASTIC PIPE

Look at the advantages of flexible polyethylene USS NATIONAL Plastic Pipe:

- Resists attack by rust, corrosion, acids, alkalies, salts, and other chemicals.
- Extremely tough—resists cracking and breaking due to rough handling, even at very low temperatures.
- Retains its toughness and flexibility over its entire working range from minus 90°F to plus 120°F.
- Lightweight, easy to carry, easy to handle—a 200-foot coil of 2-inch USS NATIONAL Plastic Pipe weighs only 86 pounds.
- Very low flow resistance, due to the smooth inside surface and non-wetting properties of polyethylene. Smooth interior also prevents the accumulation of deposits.
- Simple to install. The long continuous lengths of USS NATIONAL Plastic Pipe require few joints. When joints are used, they are of the insert type, quickly secured with stainless steel clamps. Light, flexible USS NATIONAL Plastic Pipe is easy to handle, thus requiring less installation time.

USS NATIONAL Plastic Pipe is available in sizes from ½-inch to 6 inches in diameter, in a variety of wall thicknesses. It is sold and serviced by the same distributor organizations that handle USS NATIONAL Steel Pipe. For further information, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa. Ask for Bulletin No. 29.



SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS NATIONAL *plastic* PIPE

UNITED STATES STEEL

For more information, turn to Reader Service Card, Circle No. 407

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Handy 'scopes spot-check production, speed small parts work

- Actual size as shown here ... compact, handy
- Shows natural right-side-up views... easier for inexperienced users... a big help in precision assembly!

Just grab this dependable inspection aid for on-the-spot checks of work and materials in any phase of production. Available with folding tripod or sturdy microscope stand, for detailed study and for small-parts assembly. You can even build it right into production machinery!

Upright images are sharp and detailed to the very edge of the extremely wide field of view. Long working distance makes it easy to manipulate specimens ... gives operators plenty of room for precision assembly and repairs. (Also available as straight tube for applications where upright image is not required.)

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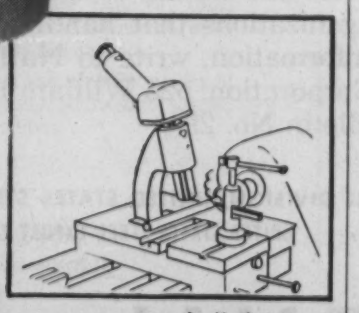
Find out how this inexpensive production tool can lower your manufacturing costs. WRITE, WIRE or PHONE today for free demonstrations and Data Bulletin D1052. Bausch & Lomb Optical Co., 79343 St. Paul St., Rochester 2, N. Y. (Phone: LOcust 3000).

Use it in tripod...

in microscope stand...



...or even built into machinery!

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AMERICA'S ONLY COMPLETE OPTICAL SOURCE ... FROM GLASS TO FINISHED PRODUCT

news of SOCIETIES

neers' James Watt International Medal in London recently, in recognition of his contribution to engineering progress.

The **American Zinc Institute** has elected F. S. Mulock as president. Mr. Mulock is president of U. S. Smelting, Refining & Mining Co.

The **Copper & Brass Research Assn.** has announced the election of Austin R. Zender, executive vice president, Bridgeport Brass Co., to presidency of the Association.

The **Drop Forging Assn.** has elected to its Board of Directors Gordon R. Walker, president, Walker Forge, Inc., and Walter E. Lindell, president, Lindell Drop Forge Co.

The **Metal Powder Assn.**, at its annual meeting in Philadelphia, elected Morris Boorky president of the Association. Mr. Boorky is president of Presmet Corp. and also chairman of the Fabricators Div. of the Association.

Michigan State College has recently presented Dr. Maurice J. Day, director of research and development, Crucible Steel Co. of America, a special Centennial Citation and Award "for his years of service in the field of metallurgical research and development" and his "distinguished contributions both to the theory and the practice of metallurgy".

The **National Electrical Manufacturers Assn.** has appointed Joseph F. Miller as managing director to succeed William J. Donald who recently retired.

The **Scientific Apparatus Makers Assn.** has elected Henry F. Dever as president. Mr. Dever is president, Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

The **Trinks Industrial Heating Award Committee** has presented the Trinks Award to Walter H. Holcroft, executive vice president and technical director, Holcroft & Co., for his outstanding contributions to gas carburizing and carbo-nitriding in heat treating steel. Two other engineer-executives, similarly honored for their contributions to economic and scientific progress in the industrial heating and related fields, were Horace Drever, president, Drever Co., and C. E. Hawke, vice president, the Carborundum Co.

(Meetings & Expositions on p. 208)

It's Fast
It's Thorough
It's Economical

It's your Best Buy in Degreasing Agents!

Nialk® TRICHLORethylene

When you stack up all the advantages offered by Nialk TRICHLORethylene you'll understand why more and more companies are standardizing on it for metal parts degreasing.

Versatile—the ideal organic solvent for removing practically every kind of foreign matter—waxes, greases, oils, gums, tars—even chips. Leaves parts clean, warm, dry, ready for assembly, inspection or surface treatment.

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Thorough—Low viscosity (0.58 centipoises at 20°C) and low surface tension (about 29 dynes per cm at 30°C) assure diffusion into pores and relatively inaccessible openings.

Economical—Stable and completely usable after distillation. Cuts power consumption . . . can be heated by gas, steam or electricity. Gives concentrated vapor at only 188°F. Specific heat is less than ¼ that of water. Cuts vapor loss—high vapor density (4.5 times that of air) assures proper vapor level at all times.

Safe—Has neither flash point nor fire point; classed as nonflammable at room temperatures, only moderately flammable at higher temperatures (Underwriters' Laboratories rating 3).

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For more information, turn to Reader Service Card, Circle No. 401

A Good Fisherman Doesn't Trust to Luck

Alodized aluminum canoe designed and built by Metal Boat Company Division of Grumman Aircraft Engineering Corporation, Marathon, N. Y.

Grumman

Successful angling is the result of studying feeding habits, selecting the proper lure and the right equipment. To catch bass, and other game fish requires a different technique for each species. The good fisherman doesn't trust to luck.

Similarly, there's no substitute for "Know-How" and that's particularly true in adapting metal treating chemicals to established production. It can't be gotten out of books. through black magic or out of a crystal ball. Only years of active contact, with actual manufacturing procedures, can be depended upon for satisfactory solutions of the metal protecting problems constantly confronting manufacturers.

ACP offers ideal products for removing and preventing rust on metal, chemicals to bond paint to steel, zinc, and aluminum, and pickling acid inhibitors. In addition, ACP furnishes a free service of an organization of technical experts with over 40 years' experience in solving metal preservation problems for the largest as well as the smallest operation.

Rely on service backed by experience. You are obligated in no way by consulting our technical staff.

Write or call for further information on ACP chemicals for metal protection.

AMERICAN CHEMICAL PAINT COMPANY
Ambler, Pa.
Detroit, Mich. *Niles, Calif.* *Windsor, Ont.*

CHEMICALS ACP PROCESSES

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Meetings & Expositions

SOCIETY OF AUTOMOTIVE ENGINEERS, West Coast meeting. Portland, Ore. Aug. 15-17, 1955.

METALWORKING MACHINERY & EQUIPMENT EXPOSITION. Chicago. Sept. 6-17, 1955.

PRODUCTION ENGINEERING SHOW. Chicago. Sept. 6-17, 1955.

NATIONAL MACHINE TOOL BUILDERS ASSN., machine tool show. Chicago. Sept. 6-17, 1955.

METAL POWDER ASSN., fall meeting. Hot Springs, Va. Sept. 9-11, 1955.

SOCIETY OF AUTOMOTIVE ENGINEERS, tractor meeting and production forum. Milwaukee. Sept. 12-15, 1955.

PORCELAIN ENAMEL INSTITUTE, Annual Shop Practice Forum. Columbus, Ohio. Sept. 14-16, 1955.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS. Lake Placid, N. Y. Sept. 25-28, 1955.

STANDARDS ENGINEERS SOCIETY, fourth annual meeting. Hartford, Conn. Sept. 29-Oct. 1, 1955.

WORLD PLASTICS FAIR AND TRADE EXPOSITION. Los Angeles. Oct. 5-9, 1955.

NATIONAL FOUNDRY ASSN., annual meeting. Chicago. Oct. 6-7, 1955.

ELECTROCHEMICAL SOCIETY, fall meeting. Pittsburgh. Oct. 9-13, 1955.

SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic meeting, aircraft production forum and aircraft engineering display. Los Angeles. Oct. 11-15, 1955.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals Div., fall meeting. Philadelphia. Oct. 17-19, 1955.

AMERICAN SOCIETY FOR METALS, National Metal Congress and Exposition. Philadelphia. Oct. 17-21, 1955.

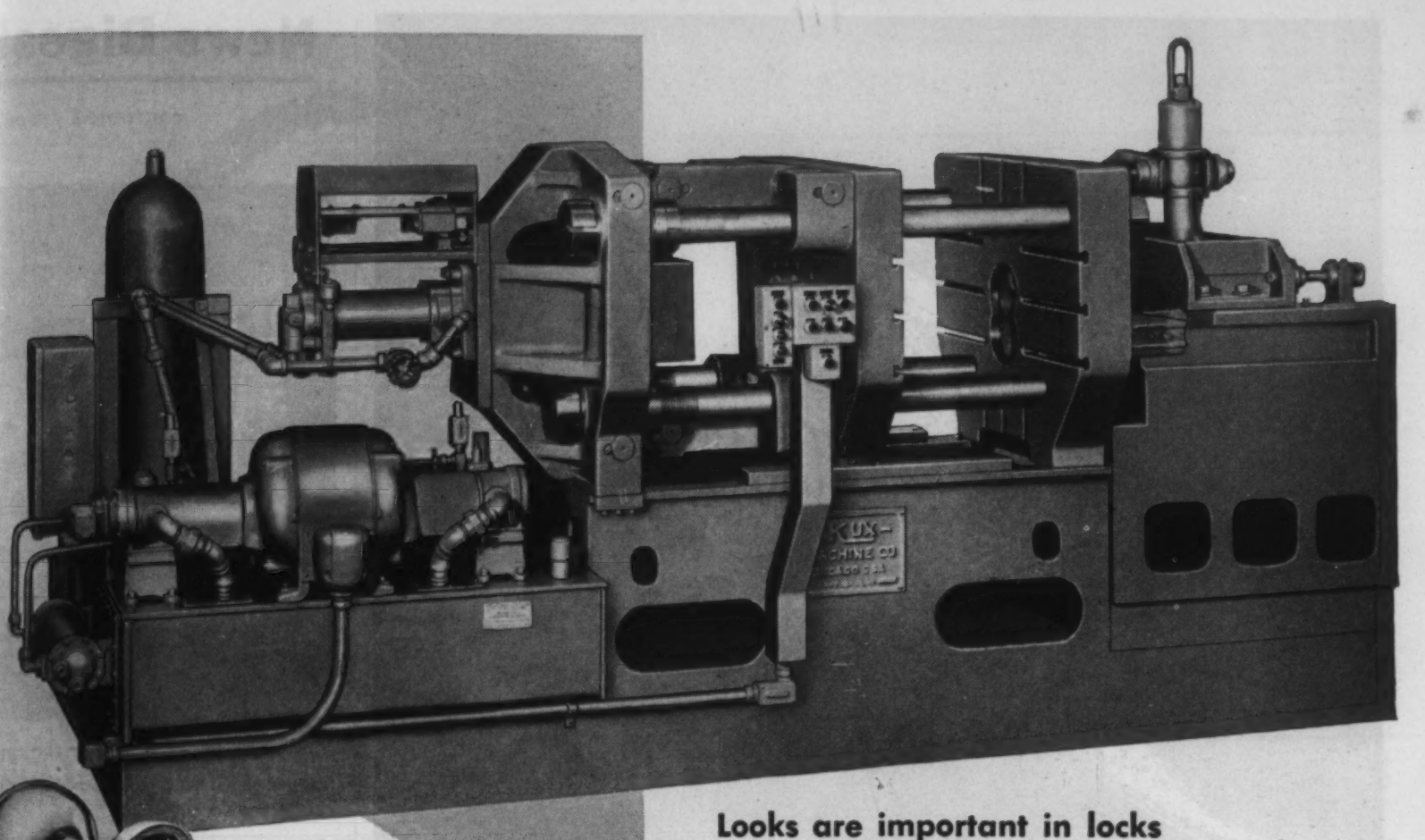
AMERICAN WELDING SOCIETY, national fall technical meeting. Philadelphia. Oct. 17-21, 1955.

GRAY IRON FOUNDERS' SOCIETY, annual meeting. Milwaukee. Oct. 19-21, 1955.

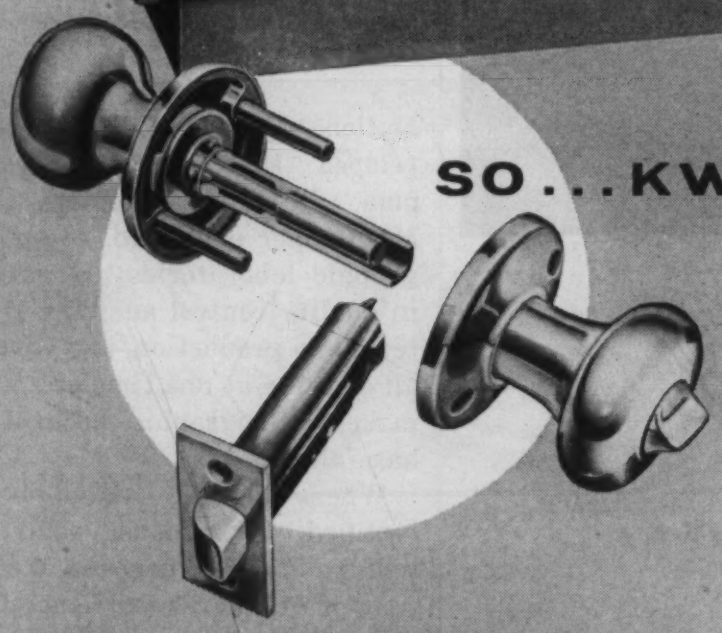
STEEL FOUNDERS' SOCIETY OF AMERICA, fall meeting. White Sulphur Springs, W. Va. Oct. 24-25, 1955.

PORCELAIN ENAMEL INSTITUTE, annual meeting. White Sulphur Springs, W. Va, Oct. 26-28, 1955.

MAGNESIUM ASSN., annual meeting. New York. Oct. 31-Nov. 1, 1955.



Looks are important in locks



SO...KWIKSET CHOSE

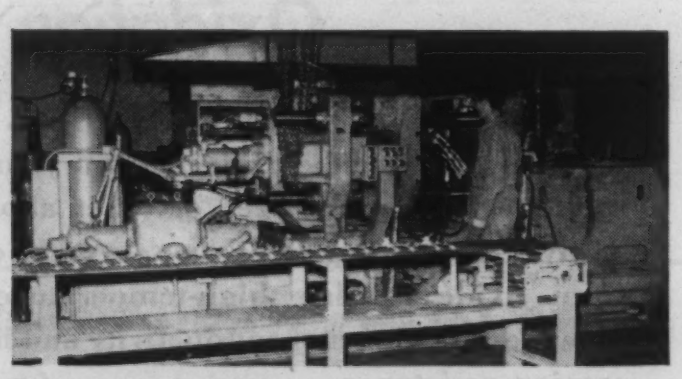
KUX
DIE CASTING MACHINES

to get hardware finish quality

Locks must have eye appeal to sell . . . they must be economically priced . . . easy to install . . . and offer long trouble-free service. Kwikset Locks, Inc., Anaheim, Calif., has achieved all these things which accounts for the more than 25,000,000 of its "400 line" of locksets now in *unconditionally guaranteed* service.

KUX die casting machines have played an important role in this remarkable record. Many of the individual parts that make up the three easy-to-install precision-matched components of a "400" lockset are die cast. KUX machines are used because Kwikset knows a hardware finish quality is obtained on every gate cast. A dense hardware finish quality on a close tolerance casting reduces costs throughout the manufacturing and assembly processes and puts Kwikset in a fine competitive position.

KUX produces a full range of modern die casting machines that require only the touch of an electric button to put them automatically through a complete casting cycle at high production speeds. KUX engineers will be glad to show you how die casting machines can serve you. Or, write for an illustrated catalog.



The New MODEL BH-30

This new, more powerful, higher speed model shown above, is a hydraulically operated gooseneck plunger type of machine for production of zinc, lead or tin die castings. It is one of the many KUX machines in operation at the Kwikset plant.

KUX | **MACHINE CO.**
6725 NORTH RIDGE AVENUE
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***New* High-Temp Oxidation Resistance**

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Metal Hydrides' metallurgical engineers will be happy to give you more information, without obligation. Call, wire or write today.

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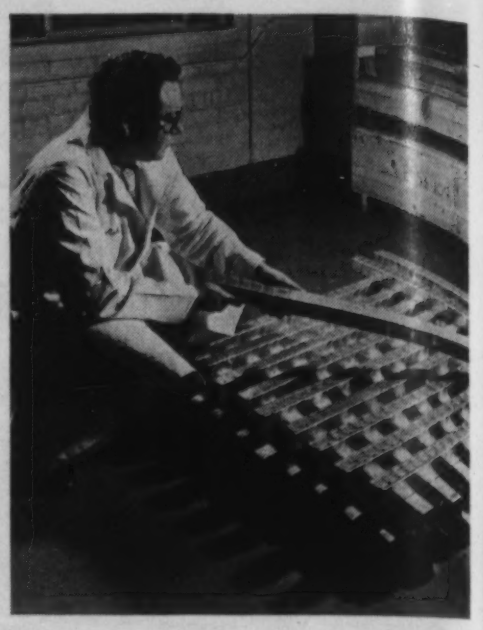
News Digest

continued from page 14



***Zinc bars** from continuously-cast ingots will be cut up, used as standards.*

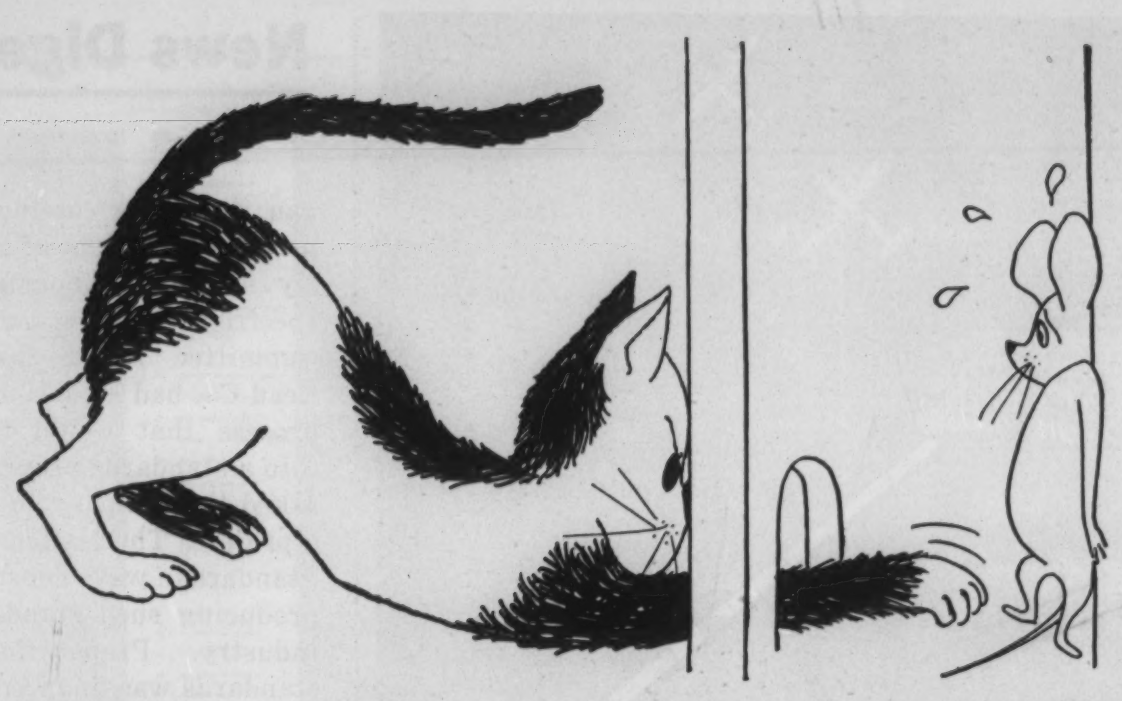
National Bureau of Standards developed the over-all standards plan. In General Motors alone, Mr. Cooper explained, 44 spectrographic laboratories are engaged in quality control analyses of materials in production, and virtually all of these at one time or another make spectrographic checks of zinc base alloys.

When the new standards are certified, Mr. Cooper said, they will be divided between the Bureau of Standards and General Motors. GM's share will be distributed within the corporation. The Bureau of Standards will make its portion available commercially on a national scale to any industry needing accurate spectrographic standards.

The standards themselves are segments about one inch long and 1¾ in. in cross section cut from a continuously cast bar of 333 ft, longer than a football field. One of the major problems was to cast and test the long bar to be sure that all the one-inch segments are identical in composition.

Their composition must be determined accurately by laboratory tests that include chemical, spectrographic and metallographic analyses, Mr. Cooper reported.

Groundwork for the project, he said, began when GM's Spectrographic Committee, which is chairmanned by Mr. Cooper, be-



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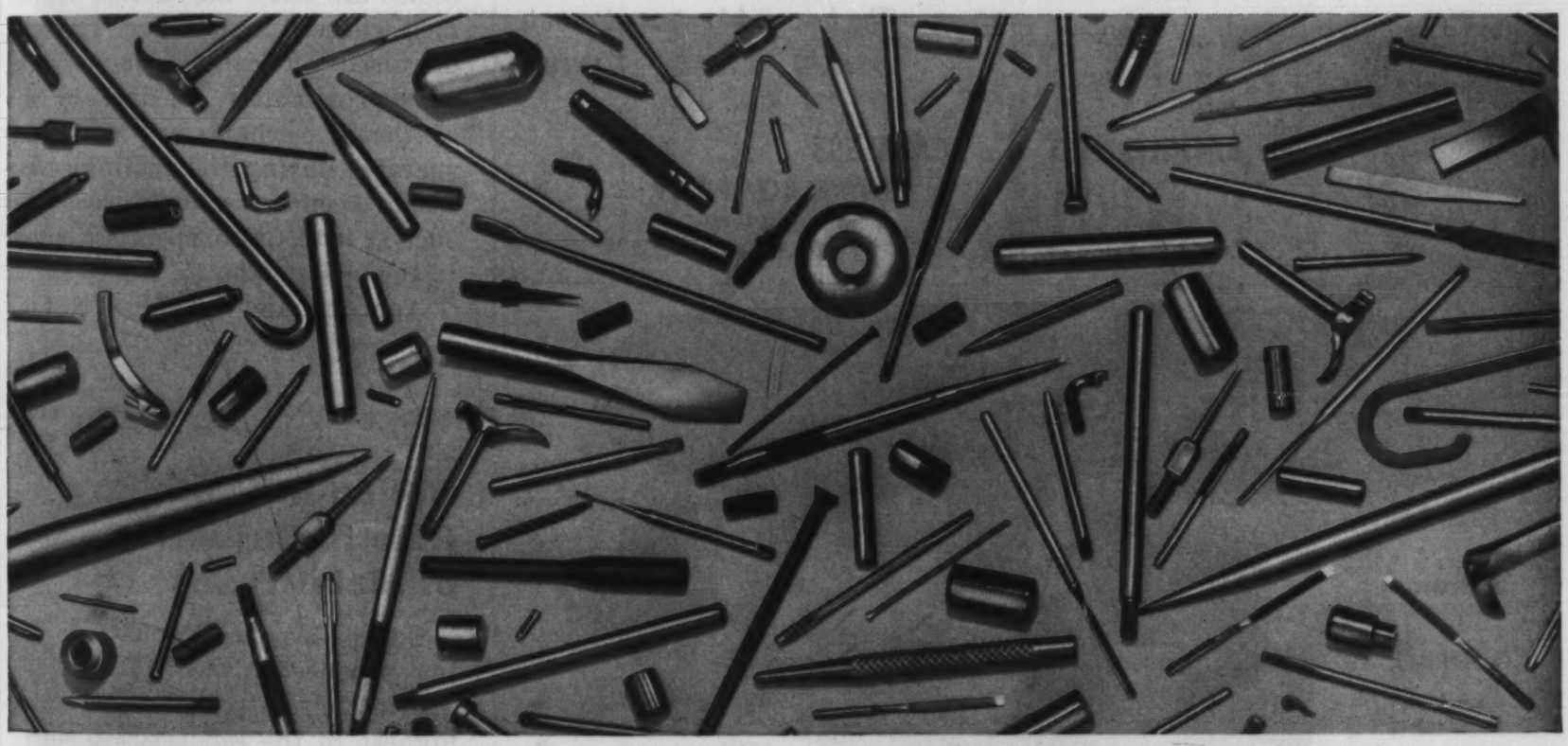


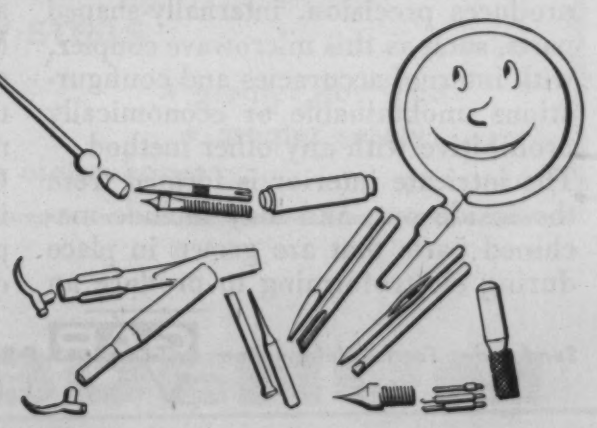
When you want "precision," you can count on Torrington. Almost 90 years devoted to producing metal parts exactly to the tolerances specified by customers assures you parts exactly "as ordered."

What's more, Torrington can give you the temper, hardness and finish you want—in any quantity—*faster, better and for less* than you can produce them yourself. Send your blueprint or a sample part for our quotation. And ask for our Condensed Catalog, showing many types of parts on which you can save.

THE TORRINGTON COMPANY
Specialties Division
777 Field Street, Torrington, Conn.

TORRINGTON *SPECIAL* **METAL PARTS**

Makers of Torrington Needle Bearings



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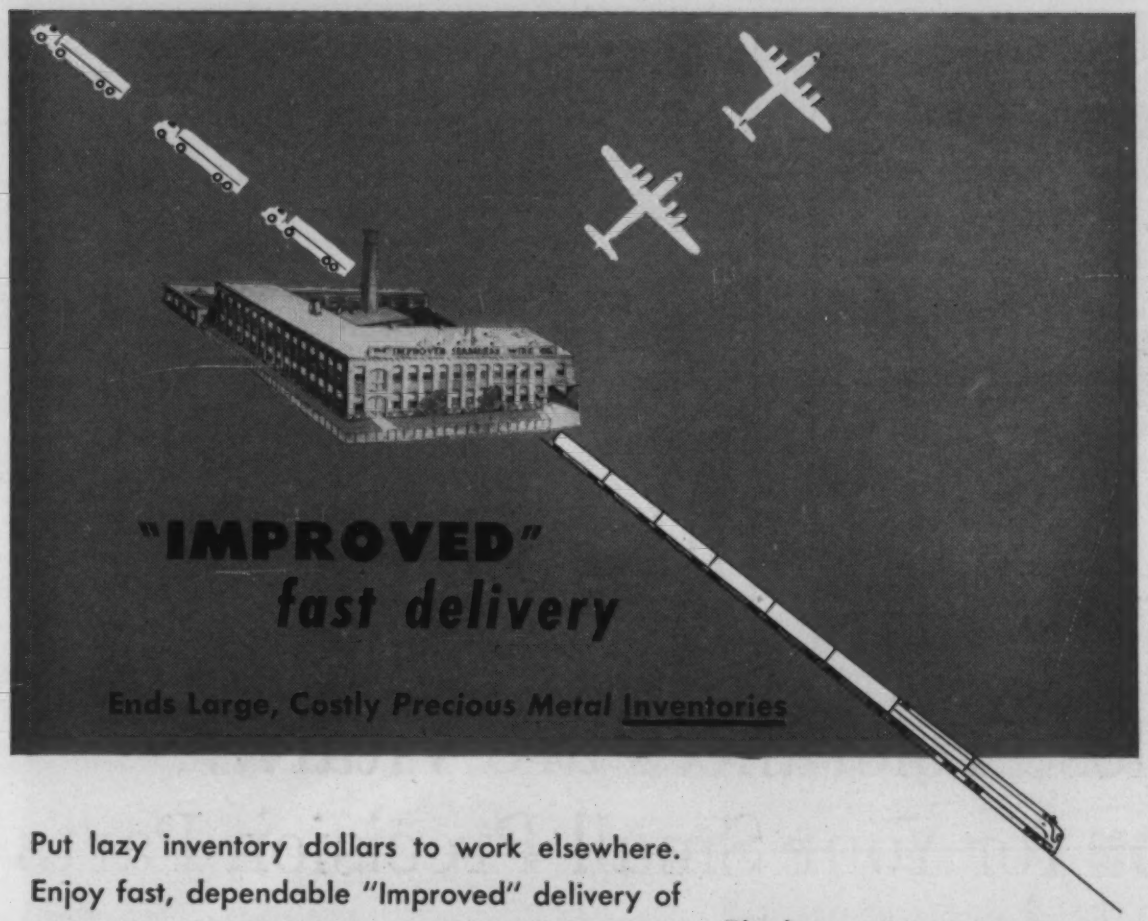
For more information, turn to Reader Service Card, Circle No. 368



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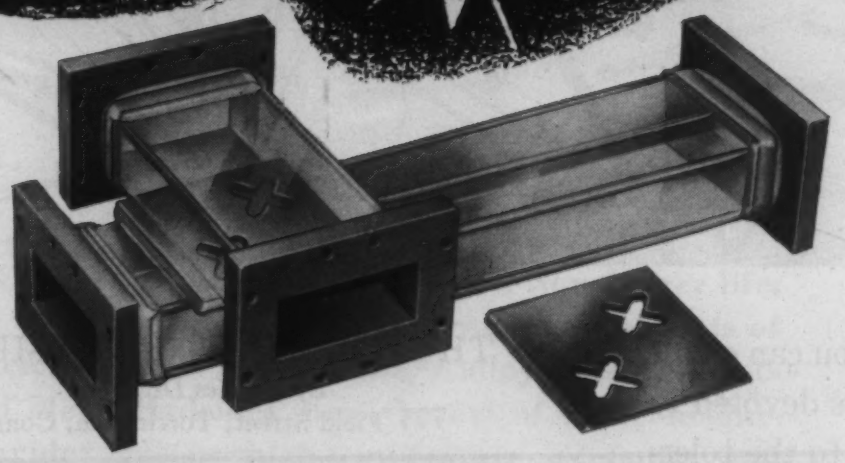
for extreme accuracy and exact duplication



complex internal shapes made "INSIDE OUT"

This unique electroforming process produces precision, internally-shaped parts, such as this microwave coupler, with internal accuracies and configurations unobtainable or economically prohibitive with any other method.
The intricate interior is formed from the inside out, and may include machined parts that are grown in place during electroforming to produce an integral assembly of unusual accuracy, rigidity, and lightness.
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News Digest

gan seeking a casting method to produce large lots of zinc base alloy sufficiently homogeneous for spectrographic standards. The committee found that National Lead Co. had a continuous casting process that would fit naturally into a standards program, and GM asked the company to arrange for a project. The National Bureau of Standards was consulted about producing such standards for all industry. Preparation of the standards was financed by GM Research Laboratories.

Mr. Cooper described the technique by which the zinc alloy is cast as a continuous bar, with molten metal flowing into a water-cooled die below the surface of the melt where it is solidified. The bar is raised vertically in increments of approximately one inch by an overhead mechanism. A stirrer operates during the casting process to keep less soluble elements, such as iron, uniformly distributed in the molten alloy.

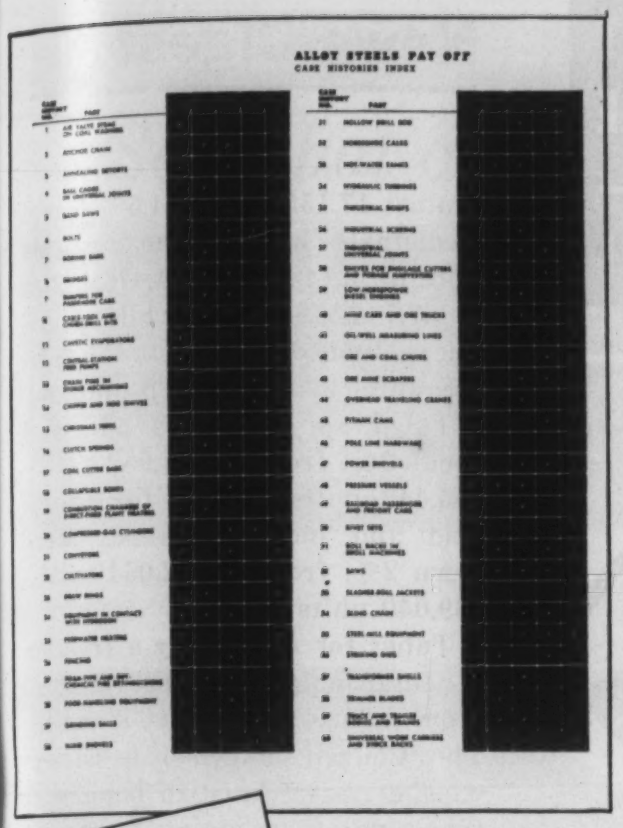
Approximately 3000 lb is cast in each heat.

Billion-A-Year Rate in Output of Metal Tubes

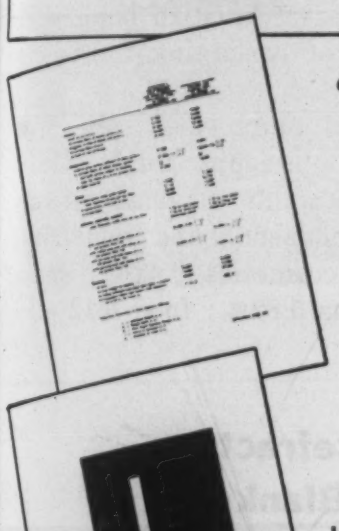
Collapsible metal tubes are being produced at the rate of approximately a billion per year, highest in the industry's history. Lester B. Platt, executive secretary of the Collapsible Tube Manufacturers Council reported that industry shipments totaled 337,360,320 units in the first four months of 1955 compared with 325,910,160 units in the same period last year.

The 16 manufacturers in the industry turn out fold-up containers for medicinals and pharmaceuticals, food, household and industrial products, cosmetics, shaving creams and dentifrices. Platt said gains were made in five of the six product classifications.

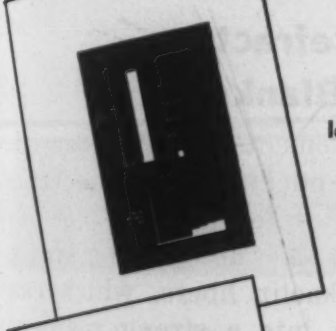
Collapsible tubes for shaving creams continued to gain. Shipments totaled 19,632,528 units as



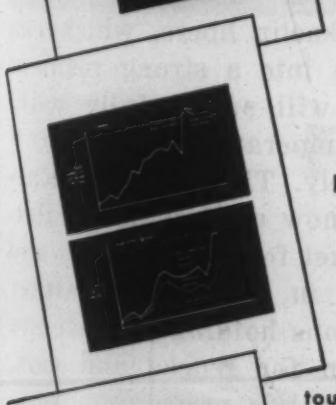
60 fully documented case histories



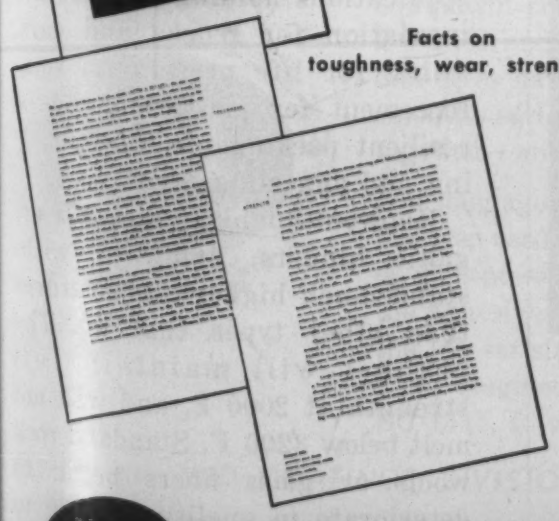
Facts on maximum pay load



Facts on lower operating costs



Facts on lower corrosion rate



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- greater pay load
- lower operating costs
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- less maintenance

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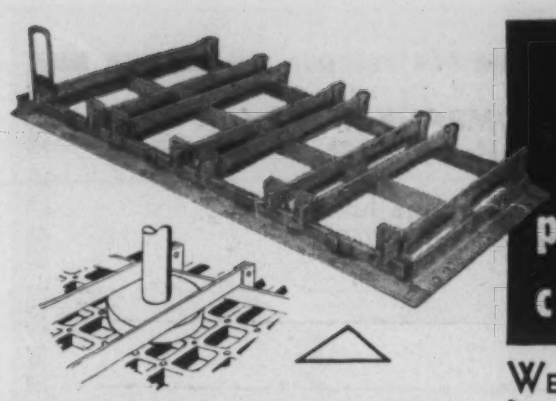

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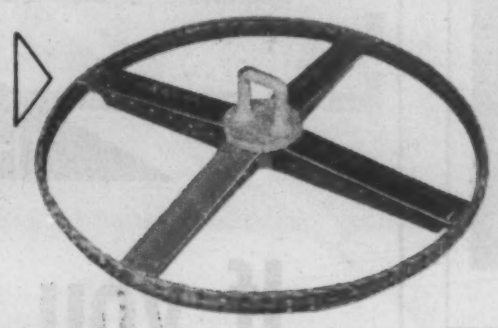
Stanwood Retaining Fixture (No. 330) handles gear blanks with integral shafts in vertical position, as shown in drawing. All retaining bars are locked or unlocked at once. Entire unit fits on a furnace car.

WE have designed and supplied many unusual fixtures, over the years, to handle parts through heat treating, quenching, pickling and similar operations. Experienced Stanwood engineers always come up with a practical solution.

Wire Coil handling fixture (No. 339), 6 ft. in diameter, for use in high temperature furnace. You are assured of the correct heat and corrosion resistant alloys and proper design if Stanwood supplies the fixtures. Send for Catalog.



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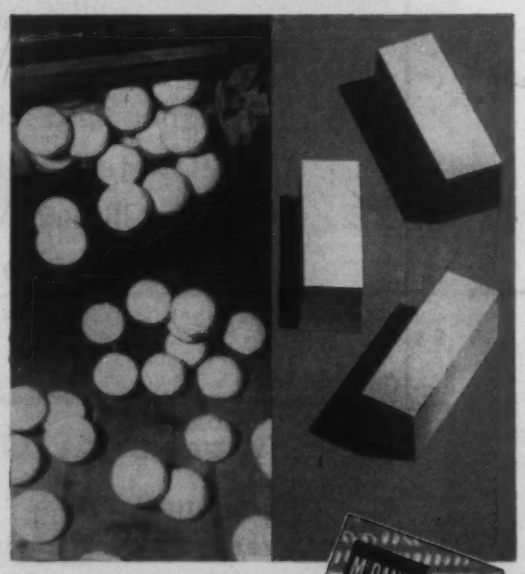

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News Digest

against 17,155,296, a 14.5% jump. Medicinals and pharmaceuticals were up 5.1%, from 64,476,432 to to 67,744,576 units, while dentifrices climbed 4.8% from 155,865,168 units to 163,329,120 units.

Tubes for cosmetics advanced about 2%, from 31,421,952 to 31,754,448 units. Those for household and industrial items were down 2%, from 56,762,064 to 55,499,040 units.

Tubes for foods, only a fraction of total output, almost doubled from 229,248 to 400,608 units. The Council launched a nationwide drive in April to popularize this type of packaging for paste-like foods.

Of total shipments, tubes for dentifrices account for 48.41%; medicinals and pharmaceuticals 19.79%; household and industrials 16.45%; cosmetics 9.41%; shaving creams 5.82%; food 0.12%.

New Refractory Fiber Blanket

Improvements in refractory fibers are pushing back the thermal barrier for blanket-type insulation. A new, long-staple wool of kaolin fibers, which can be woven into a strong resilient blanket, will successfully withstand temperatures of 2000 F indefinitely. The material, Kaowool, is now used as an insulating blanket for afterburners and tailpipes in jet engines. Other applications holding promise are insulation for trucks and cars, filling for life preservers, reinforcement for plastics and as a resilient packing for kilns, ducting and annealing ovens.

Kaowool blankets use no organic binders, and will withstand much higher temperatures than other types that do. The blanket will maintain full strength at 2000 F, and will not melt below 3200 F. Standard rock wools or glass fibers begin to deteriorate in quality at 1000 to 1200 F.

The longer fibers used in the

Fastening Formica® to stay

What's going *under* the counter in today's modern kitchens? In many progressive kitchen-equipment companies, it's the 3M adhesives EC-1357 and 1368. These "quick grabbing" adhesives have what it takes to bond satiny smooth surfaces like Formica and steel together—and bond them to stay.

Not long ago, however, this particular manufacturer used *wood* bases for all counter tops of high-pressure laminates like Formica. All the adhesives tried on steel just wouldn't do the job satisfactorily. But along came a 3M Field Engineer to point out the talents of EC-1357. It was tried . . . proved . . . used. Now this manufacturer can skip the wood bases and make cabinets *all steel*. His gain? Important production economies in both material and handling . . . while offering a better, longer-lasting cabinet in the bargain.

See what adhesives can do for you . . . This is just one example of the work being done by over 1000 specialized 3M adhesives, coatings and sealers in industry today. Among them may be the specific products to solve *your* design or production problems. Find out by talking to an expert; call in your nearest 3M Field Engineer. Or write 3M, Dept. 67, 417 Piquette, Detroit 2, Mich.

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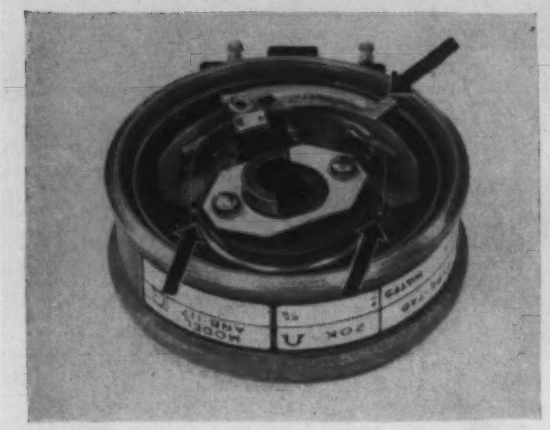

Arrows point to Paliney #7 contacts used in this Fairchild Type 746 Precision Potentiometer.

NEY'S small parts play a BIG part in precision instruments

Reliability of many precision electrical instruments depends upon accurate transmission of electrical signals between moving parts. The Potentiometer Division of the Fairchild Camera and Instrument Corporation has selected Ney Paliney #7* for use as wipers and sliders in their precision potentiometers because Paliney #7 provides the important advantages of a long life with excellent linearity and the ability to hold noise at a minimum.

Ney manufactures many other precious metal alloys which, like Paliney #7, have ideal electrical characteristics, high resistance to tarnish, and are unaffected by most industrial atmospheres. Ney Precious Metal Alloys have been fabricated into slip rings, wipers, brushes, commutator segments, contacts, and intricate component parts and are used in high precision instruments throughout industry. Should you have a contact problem, a call to the Ney Engineering Department will result in study and recommendations which will improve the output of your electrical or electronic instruments.

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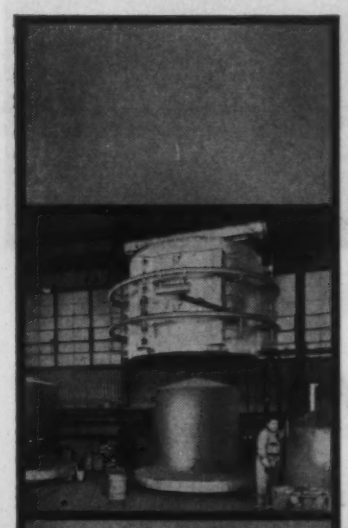
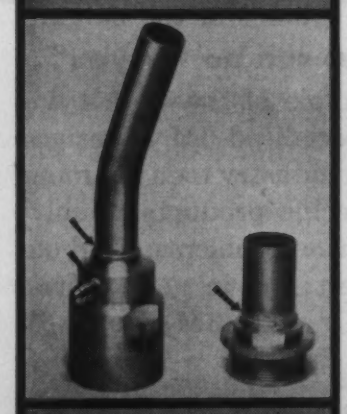


72-inch diameter hydrogen atmosphere furnace being lowered over furnace bell.



Three brazed joints in jet engine water alcohol valve, utilizing Nicrobraz alloy.

Stainless Joining Problems?

If you must join (or harden, or anneal) stainless steel, then Wall Colmonoy Corporation's Stainless Processing Division can help you. Using Nicrobraz alloy, they produce brazed joints in stainless assemblies that equal the parent metal in tensile strength, at service temperatures of 2000° F. Nicrobraz also has excellent corrosion and oxidation resistance, qualifying it for use in aircraft, pharmaceutical, petroleum, and chemical industries.

Wall Colmonoy maintains three conveniently located plants, equipped with the latest in equipment and skills. Let them handle your experimental and production stainless steel processing and brazing.

Titanium Joining Problems?

The Detroit plant is now brazing and vacuum annealing titanium and its alloys. A new fluxless method has been developed, permitting distortion-free brazing of titanium to titanium, stainless steels, and low alloy steels. Call Detroit for help on titanium joining problems.

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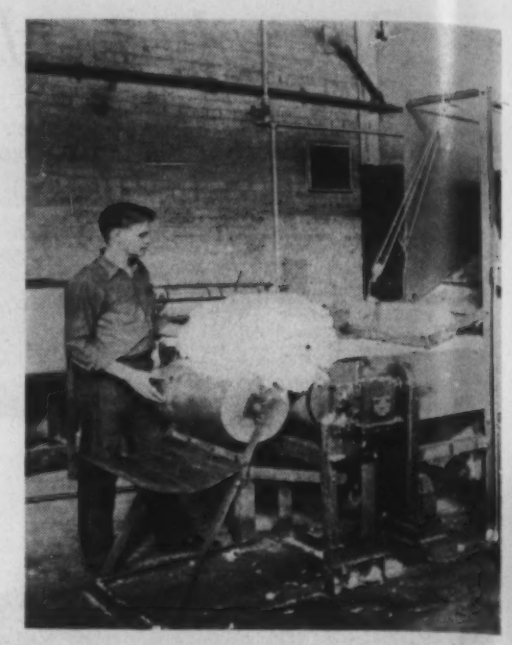
News Digest



***Roll of Kaowool** emerges from fiber-laying equipment.*

refractory blankets have high coherence, and the blankets can be hung inside an enclosure without settling or requiring retaining walls.

How it's made

Kaowool is a pure white homogeneous fiber made by melting and blowing kaolin, the clay from which it takes its name. The material is made by melting kaolin clay electrically, forcing it through a tapping nozzle and blowing it into fibers. The fibers are collected on a pad-forming conveyor. New blowing nozzles produce fibers about 8 in. long with a diameter of 3 microns. The fibers are almost completely shot-free, and the blankets have a soft cottony texture. Kaowool in its "as blown" condition is now equal to many competitive wools after they have been subjected to a cleaning process (which is costly and tends to weaken or break down the fibers of wool). Kaowool is now rolling off a small pilot plant at the Babcock and Wilcox Co.'s Research Div. at the rate of half a ton a day. A full scale plant is under serious consideration, as a result of recent B&W experimental work indicating that a full scale production process can be adapted from the pilot plant without too much difficulty.

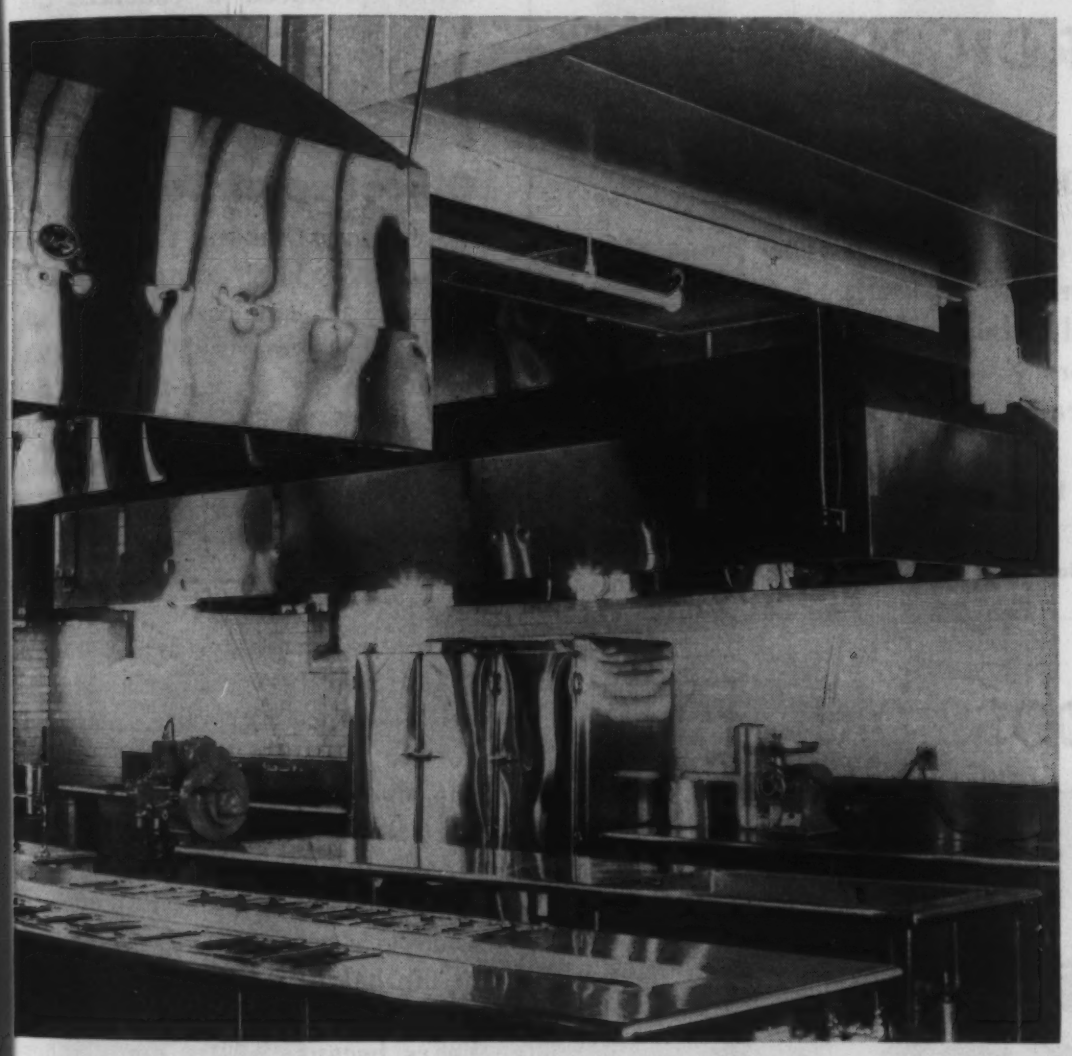
B&W's research laboratories

Washington Steel News

PUBLISHED BY WASHINGTON STEEL CORPORATION, WASHINGTON, PA.

Stainless Steel Buyers:

SAVINGS OF $145 PER TON NOW POSSIBLE WITH *MicroRold*® STAINLESS STEEL



TYPICAL INSTALLATION OF MICROROLD TYPE 430—This Kitchen and Bakery Building of the South Carolina State Hospital, Columbia, S.C., is the largest institutional combined kitchen and bakery in the southeast. 18 gauge Type 430 stainless steel is used extensively in 17 exhaust and equipment hoods. They are designed for strength, appearance, and sanitation and were fabricated by Earl DeLay & Co. of Columbia, S. C.

7¼¢ Per Lb. Price Differential Between Types 430 and 302 Results in This Substantial Savings

By specifying MicroRold Type 430 stainless steel for suitable applications, stainless steel buyers can take advantage of the 7¼c per pound difference in base price between Type 430 and Type 302 stainless. A saving of $145 per ton merits consideration. Type 430 is a straight chromium-stainless with a nominal composition of 17% Chromium. During the Korean conflict, Type 430 was used extensively, due to government restriction on nickel-bearing stainless.

WIDE USE FOR TYPE 430

While Type 430 does not possess the same degree of corrosion resistance as Type 302, it has proven very satisfactory in a wide range of mild corrosion applications, both interior and exterior. It lends itself to a multitude of decorative and functional uses, combining all the advantages and qualities of stainless steel — beauty, strength, corrosion resistance, long life, workability and ease of maintenance. Considering the price advantage, with no sacrifice in quality when applied properly, stainless steel buyers will find MicroRold Type 430 a worthwhile material for an impressive number of stainless steel applications.

EXTRA SAVINGS

Washington Steel Corporation not only points out the savings and advantages that may be acquired through the selection of Type 430, but also the significant economies in its production of all stainless types. Special production equipment and methods produce controlled accuracy of gauge throughout length and width of the entire sheet; thus, MicroRold may be specified by decimal thickness (with tolerances as low as 3% average) instead of gauge number. By specifying MicroRold sheet rolled to the light side of the gauge range, purchase costs are reduced by the savings in weight. While this saving may not be apparent in every single sheet, weights will average less than the theoretical when bought over a period of time. **Your steel distributor can give you full information on how you can get the most out of your stainless steel dollar. He will gladly tell you the MICROROLD STORY.**

Type 430 Satisfactory For Mild Corrosion Applications

This straight chromium-stainless grade possesses desirable properties that recommend it for a diversity of applications under general atmospheric conditions. It is non-hardenable by heat treatment and is only mildly hardenable by cold working. It has moderate ductility, good forming and bending characteristics and can be drawn to a moderate degree.

Brazing and soldering are easily accomplished, and except where resistance to high stresses is a major factor, it welds satisfactorily by the usual methods. Before fabricating MicroRold Type 430, it is advisable to consult our mill or distributor to make certain that it may be used successfully in your particular application.

Type 430 Good Insurance Against Shortage Of Nickel Types

Any restriction or curtailment of nickel-bearing stainless (as during the Korean Engagement) could have serious effect upon stainless steel fabricators. By making use of Type 430 wherever feasible, stainless fabricators can insure themselves against any unforeseen developments in the supply of stainless steel.

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For more information, turn to Reader Service Card, Circle No. 432

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News Digest

have several other refractory projects in the fire which include high grade oxide and silicon carbide brick, insulating firebrick, refractory plastics, castables and mortar. B&W developed the first high temperature concrete resistant to 3000 F and is continuing to push back the temperature range. They recently produced a concrete that withstood 3200 F successfully.

Elimination of Tin Objective of Can Co.

"Foremost among the American Can Co.'s long range research project is the quest to eliminate this country's dependence upon tin as a can-making raw material," newsmen and guests were told at ceremonies unveiling the new research and development laboratories of the American Can Co. The big canmaker has even tagged its tin substitute program with the military-style name—"Operation Survival." Can makers are seeking alternate materials for tin "for a number of reasons, the most important of which is that tin has always made the container industry a servant to its supply" according to American Can Co.'s representatives.

Tin has been the can industry's vital raw material for over 100 years because of its many inherently desirable characteristics in food preservation. While the average can is 99% steel and only 1% tin, to date no non-metallic material or other metal has been found that is so universally effective as tin in protecting a great variety of canned products. Tin is also desirable because it alloys readily with steel and acts as a natural lubricant during can fabrication. Also, tin plate has proved through the years to provide a surface easy to solder—and solder as a bonding agent is still the best method to seal cans for processed foods.

The can maker expects no overnight revolution, but believes that the "can of tomorrow" will evolve

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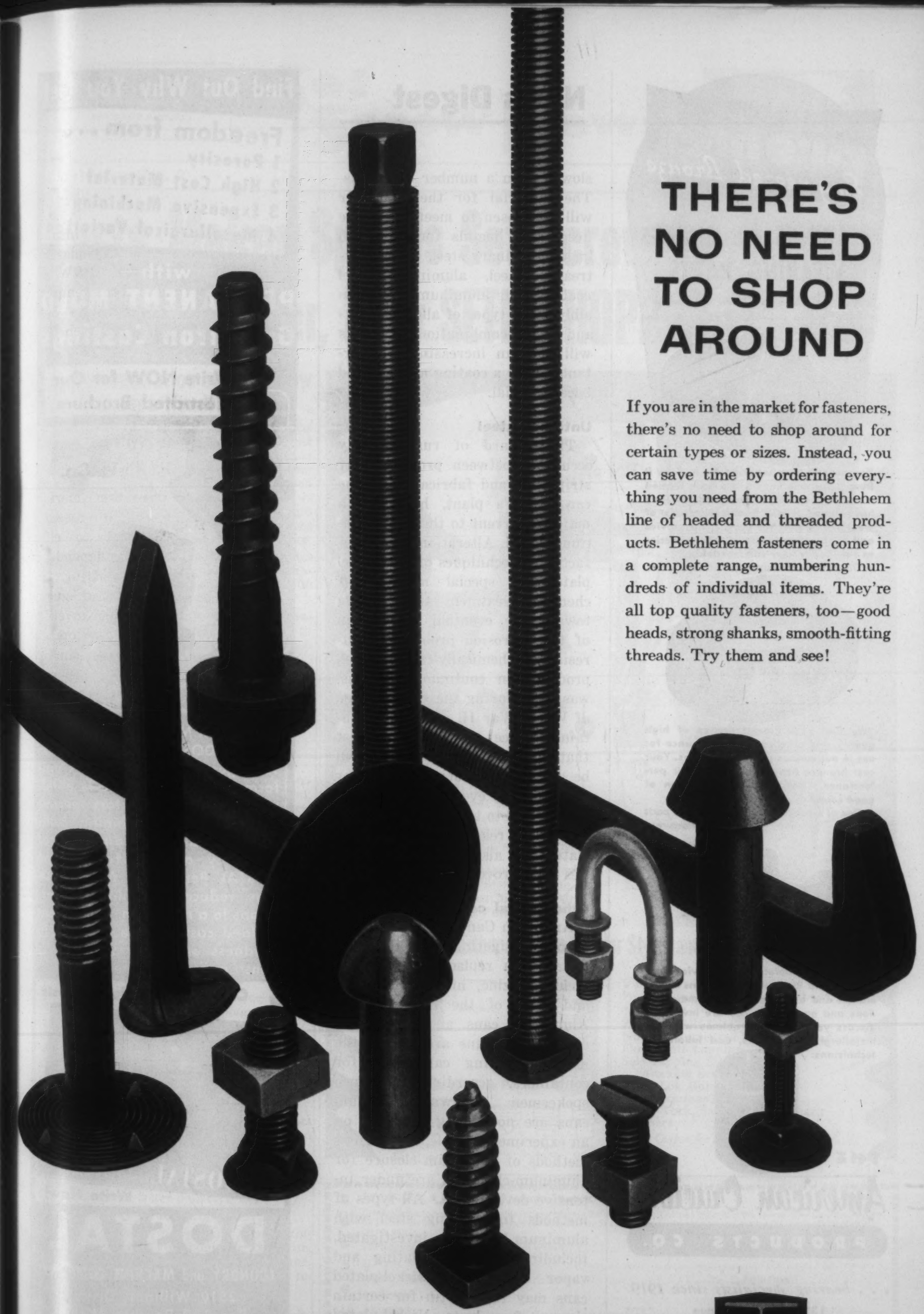

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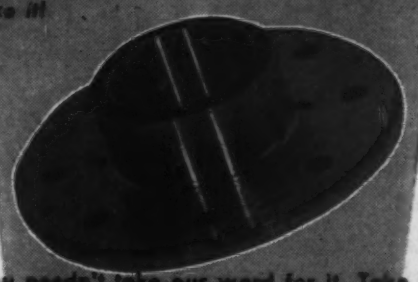

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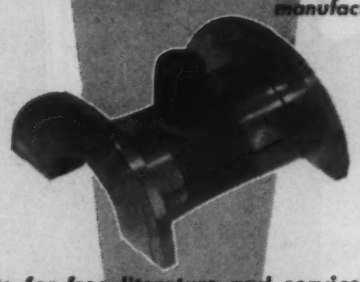
—One of America's largest tool manufacturers.

"We find your Promet bronze of high quality and excellent in performance for use in our various pump assemblies. Your cast bronzes have excelled in their performance. Castings have also been of good sound quality."
—One of America's leading automotive parts manufacturers.



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News Digest

slowly from a number of metals. The material for the container will be chosen to meet a specific need—thus metals for cans will include ordinary steel, chemically-treated steel, aluminum, steel coated with aluminum and possibly other types of alloy coatings and metal combinations. Plastics will play an increasingly important role as a coating medium and base material.

Untinned steel

The hazard of rust, usually occurring between production of strip steel and fabrication at the can maker's plant, has been a major deterrent to the use of untinned steel. Alterations in manufacturing techniques of plain steel plate and special methods of chemical treatment are pointing toward the eventual elimination of the corrosion problem. Rust-resistant, chemically-treated steel, produced in continuous process, was used during the tin shortage of World War II, and results obtained since that time suggest that chemically-treated steel will be among the first alternates for tin plate. The eventual use of CTS will depend to a large extent upon its price relationship to other plates and also upon the properties of improved can-making steel.

Other metal coatings

American Can researchers have been investigating every domestic metal as a replacement for tin, including zinc, nickel, aluminum and some of the rarer metals. Aluminum cans and aluminum-coated steel cans are among the most promising candidates for containers, according to Canco spokesmen. Drawn aluminum cans are now being produced on an experimental scale, and various methods of side seam closure for aluminum-clad cans are under intensive development. All types of methods for coating steel with aluminum have been investigated, including cladding, plating and vapor deposition. Nickel-plated cans may replace tin for certain classes of products. Nickel-plated

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Set Screw News

Issue No. 2 — EXTRA!

Parts Maker Speeds Set Screw Application 7 Times Faster, New SETKO HOPPER-FED Way

Free Demonstration at Set Screw Plant Enthuses Hundreds

Manufacturers of a wide variety of products are welcoming Hopper-Fed Headless Set Screws as the solution to speeding up set screw applications. Only a few months after their announcement, the special units used with Hopper-Fed Setko Headless Set Screws have already been widely ordered, and put into highly successful operation. These machines can be adapted to any machine of your choice.

- One Chicago parts manufacturer who applies set screws into plastics found that this equipment stepped up his production rate from 300 per hour . . . to 2000 per hour.
- Officials of a world-famous bearings manufacturing plant flew to the Setko plant to watch our demonstration and bought two sizes of the units almost instantly.
- Others who have already ordered include a pulley manufacturer . . . a Detroit motor drive maker . . . a fan-plate manufacturer.

Hundreds Watch Spectacular Demonstrations

Many manufacturers are accepting our invitation to witness, without any obligation, demonstrations of the hopper-fed set screw application at the Setko plant. They see a machine occupying about 1 sq. ft. floor space automatically rejecting misfits and feeding precision-perfect set screws mechanically from a vibrating hopper to a tube, through which they slide single-file, heads up, to arrive correctly positioned at the job, ready for driving. (See illustration.)

Industrial Magazines Enthuse over Advantages

Machinery and production magazine articles are featuring the many advantages of the hopper-fed headless set screw method . . . such as . . .

- Requires 1/5 to 1/10 the time of former methods.
- Works equally well with all metals and with plastics.
- Can be used for practically any headless set screw application, including the new Setko Self-Tapping.
- Reduces to minimum such problems as floor loss and cross-threading.
- Makes possible faster delivery.
- Permits smaller set-screw inventory.

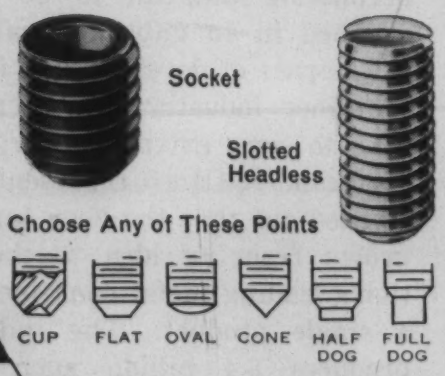
Attend one of these "hopper-fed" demonstrations at our plant, at your convenience. Write, phone or wire when you would like to come. Easier still . . . Check the demonstration request on the Coupon.

FILL OUT AND MAIL THIS TODAY ➡

(A) Complete mechanism, consisting of (1) vibrating hopper, (2) roller device that puts all the set screws "right-side-up" and (3) tube that feeds the set screws to the job, correctly positioned for driving.

(B) Close up view of tapered roller device "lining up" the screws—an exclusive Setko feature. (Pat. Pending)

Available in Either of these Popular Styles and with any Type Point



We Specialize in Solving Puzzling Set Screw Problems *by originating new developments such as these (Pat. Pending):*

- Zip-Grip Self-Locking
- Nu-Cup (increased holding power)
- Fluted Self-Tapping
- Self-Tapping Slotted Set and Fastening Screws
- Pivot-Lok (for double screw applications)
- Super-Tork, Safe-Tork and many others

Check Coupon for Bulletins or Complete Catalog

1048

SET SCREW & MFG. CO. 149 Main St., Bartlett, Illinois

☐ I would like to have a demonstration at your plant in Bartlett, Illinois (Chicago suburb) of the special operating mechanism for the new Setko Hopper-Fed Headless Set Screws. Please advise me how this can be arranged without any cost or obligation on my part.

☐ Please send bulletins on these other screws.....

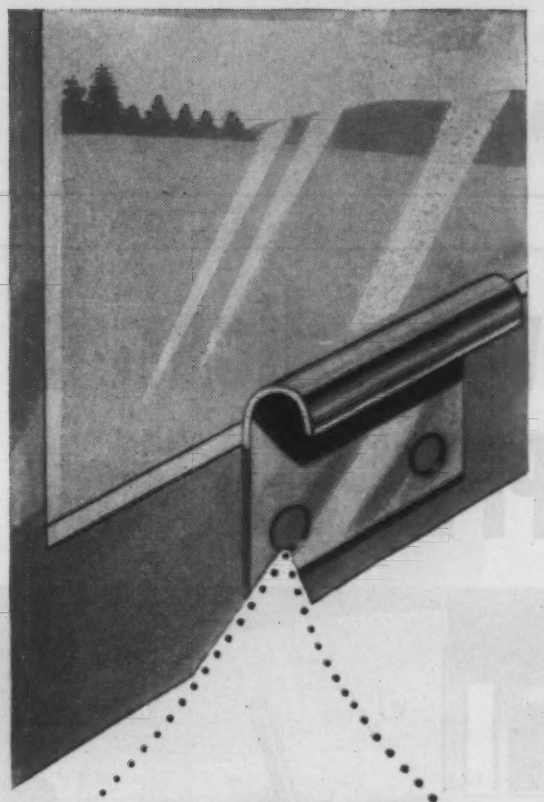
☐ Please send complete catalog.....

INDIV. NAME.....POSITION.....

COMPANY .....

ADDRESS.....CITY.....ZONE .....STATE.....

For more information, turn to Reader Service Card, Circle No. 390



An Alcoa Aluminum Fastener should be used here!

It's an aluminum window-lift assembly, worth the lasting strength of Alcoa® Aluminum Fasteners. You avoid galvanic and atmospheric corrosion. You get perfect color match; you get the very highest quality product. Your local Alcoa distributor has a complete stock.

P. S. In this window-lift assembly, we suggest an aluminum 78° countersunk rivet from Alcoa's complete line of aluminum fasteners.

Aluminum Company of America
2251-G Alcoa Building, Pittsburgh 19, Pa.
Gentlemen:
Please send complete specification data and samples of your aluminum fasteners.

name_____
title_____
company_____
address_____

Always Fasten Aluminum with Alcoa Aluminum Fasteners

For more information, Circle No. 363

News Digest

steel can be formed and soldered on conventional can making equipment.

Closure techniques

Welding and adhesive bonding are being intensively developed to replace soldering in cans made with alternate materials. High speed welding of side seams is now under way in pilot quantities. Welding offers several advantages over soldering. It is more generally applicable to a number of metals, where high speed soldering is limited. Strength tests show that welded side seams are not only stronger than soldered seams, but are stronger than the body of the container.

Welding will make non-solderable materials, such as chemically-treated steel available for sanitary type food cans. Also, welding eliminates a number of steps in soldered can production: notching, crimping and bumping are not necessary, and without these steps the speed of production should be higher than the current rate of 450 per minute for soldered-seam containers.

Cemented side seams—using a thermoplastic cement—are already on the market in a number of containers. Motor oil, liquid detergent, waxes, dry food, insecticides, polishes, and lighter fluids are a few of the products now packaged in cemented cans. The process eliminates the solder band, permitting the can to be lithographed in an unbroken pattern.

The pace of developments in the container industry can be measured to some extent by the lowly beer can. A Canco representative pointed out that the beer can has grown from an idea to the nation's leading metal container for a single product. The industry produces 6.4 billion such cans annually. When the beer can was first developed, it required three lb of tin for each 1000 cans. Today's cans require ½ lb of tin per thousand, and, according to American Can Co., tomorrow's beer can will require no tin at all.

FURTHER FACTS ON FOSBOND: ACTIVATION AND ZINC PHOSPHATIZING —HOW CALORIC USES THEM

ACTIDIP® is a remarkable new activating compound for improving zinc phosphate coatings. Steel, zinc, or galvanized parts are treated with a very dilute suspension of ACTIDIP (alone or as part of a Pennsalt Activated Cleaner) just before the Fosbond phosphatizing bath. The result is an activated surface which promotes a highly uniform coating of very small, close-packed zinc phosphate crystals. Because of rapid deposition and controlled crystal size, superior coatings of only half the weight of usual phosphates are formed . . . sludge is controlled . . . and consumption of the phosphatizing solution is *reduced as much as 40%*.

By using ACTIDIP for activation before Fosbond zinc phosphatizing, you can get (1) vastly improved corrosion-resistance under your paint film, and (2) better adhesion and gloss-retention even with one-coat paint systems. Both benefits are due to the Actidip-created small, dense crystals.

Why Caloric Activates with Fosbond

• In the Fosbond Process used on Caloric Gas Dryers (see opposite page), Pennsalt Activated Cleaner F4, containing Actidip, is combined in one spray stage with silicated heavy-duty Cleaner F7. This combination of activated and silicated cleaners removes all traces of shop dirt, greases, drawing compounds, and other unwanted films; it also provides the small-crystal benefits of Actidip mentioned above.

• After a hot-water rinse, the cleaned metal parts enter the Fosbond 10 spray section of this typical Fosbond cycle. Zinc phosphatizing with Fosbond 10® produces a dense and durable coating that protects ferrous metals against corrosion even under the most humid conditions. *The extraordinary exposure of Caloric Dryers to moisture conditions prompted Caloric's selection of Fosbond 10 for this step in the cycle.*

• The Fosbond 10 treatment is followed by a cold-water rinse. Then the coating is sealed by a final rinse in Fosrinse CP.

Immediately after this typical Fosbond cycle, the metal is ready for painting.

Complete technical information about the many Fosbond phosphatizing cycles to meet all corrosion-resistance needs is readily available to you from Pennsalt. Write Customer Service Dept., Pennsylvania Salt Manufacturing Company, Three Penn Center Plaza, Philadelphia 2, Pa.